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(Genus *Monachus*)

JUDITH E. KING

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THE MONK SEALS (Genus *Monachus*)

By JUDITH E. KING

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SYNOPSIS

An account is given of the history, distribution, features and habits of the three species of monk seal *Monachus monachus*, *M. tropicalis* and *M. schauinslandi*.

A list is given of the skulls, skeletons, skins and stuffed animals that have been examined.

The skull, dentition and skeleton are described and compared with those of other Phocidae. The members of the genus *Monachus* are shown to be much more nearly allied to the Southern than the Northern Phocids.

The relative growth rates of the various parts of the skull are given, and show that the facial region grows more quickly than the cranial region.

THE genus *Monachus*—the monk seals—consists of only three species. *M. monachus* (Hermann 1779) lives in the Mediterranean area, *M. tropicalis* (Gray 1850) in the West Indies, and *M. schauinslandi* Matschie 1905 in the Hawaiian Islands. They are interesting animals, but because of their widely scattered distribution, remoteness and scarcity, not a great deal is known about them. In this paper an attempt will be made to bring together as much information about the monk seals as it has been possible to find.

SYNONYMY

Genus *MONACHUS* Fleming, 1822

Monachus Fleming, 1822, *Philos. Zool.* **2** : 187 (footnote). *Phoca monachus* Hermann.
Pelagios F. Cuvier, 1824, *Mém. Mus. H.N. Paris*, **11** : 196. *Phoca monachus* Hermann.
Pelagius F. Cuvier, 1826, *Dict. Sci. Nat. Paris*, **39** : 550. For *Pelagios*.
Pelagus McMurtrie, 1834, Cuvier's *Animal Kingdom*, 71. For *Pelagios*.
Pelagias Gray, 1837, *Mag. Nat. Hist.*, N.S. **1** : 582. For *Pelagios*.
Pelagocyon Gloger, 1841, *Gemeinn. Naturgesch.* **1**, 34 : 163. *Phoca monachus* Hermann.
Rigoon Gistel, 1848, *Nat. Thier, für höhere Schulen. X.* New name for *Pelagios* F. Cuvier.
Heliophoca Gray, 1854, *Ann. Mag. Nat. Hist.* **13** : 201. *Heliophoca atlantica* Gray = *Phoca monachus* Hermann.

I. *Monachus monachus* (Hermann, 1779)

Phoca monachus Hermann, 1779, *Beschäf. Berlin Ges. Naturf. Freunde*, **4** : 501, pls. 12, 13.
Phoca albiventer Boddaert, 1785, *Elench. Anim.* **1** : 170.
Phoca bicolor Shaw, 1800, *General Zoology*. **1**, 2 : 254.
Phoca leucogaster Péron & Lesuer, 1816, *Voy. aux Terres Austr.* **2** : 47 (footnote).
Phoca hermanni Lesson, 1828, *Dict. Class. Hist. Nat.* **13** : 416.
Monachus mediterraneus Nilsson, 1838, *K. Svenska Vet. Ak. Handl.* **1837** : 238.
Phoca crinita Menis, 1848, *Il Mare Adriatico*, 153.
Heliophoca atlantica Gray, 1854, *Ann. Mag. Nat. Hist.* **13** : 202.

II. *Monachus tropicalis* (Gray, 1850)

Phoca tropicalis Gray, 1850, *Cat. Mamm. in colln. Brit. Mus.* part 2. Seals, 28.
—— *wilkianus* Gosse, 1851, *A Naturalist's Sojourn in Jamaica*, 308 (footnote).

III. *Monachus schauinslandi* Matschie, 1905

Monachus schauinslandi Matschie, 1905, *Sitzungs-Berichte der Gesellschaft Nat. Freunde*, Berlin, 258.

I. *Monachus monachus*

History

The monk seal appears to have been always well known to the inhabitants of the Mediterranean area. Clark (1952) notes that bones of this seal were found in upper palaeolithic levels at Grimaldi, and there is evidence that seal hunting was quite an important activity in classical Greece. The skins were collected partly for the superstitions surrounding them and partly for use as clothes by the poor fisher folk. Boots, tents and dresses made of skin were said to protect one from lightning ; a seal skin drawn round a field and then hung up by the door would save the field from hailstones, and the right flipper was supposed to be a cure for insomnia when put under the head at night. Greek writers such as Plutarch, Pliny, Homer and Aristotle knew and wrote of the seal. Aristotle must have examined one with care as he gives quite an accurate account in the *Historia Animalium*, but Keller (1887) says that on the whole the poets found the animal horrible and deformed, and objected to its oily smell. The presence of seals gave rise to many stories. The " half animal fisheaters " on the west coast of Africa were said to have made a pact with the seals not to interfere with each other's fishing, and in the *Odyssey* a woman who died on board ship was thrown overboard to serve as food for the seals and fishes. Because of their love of sun and sea the seals were put under the protection of Phoebus Apollo, the sun god, and Poseidon, the sea god. The seal was frequently shown alive in these times. Even then their docility and intelligence were noted, and Pliny tells how he saw some which answered by growls when their names were called. In earlier days there must have been more monk seals round the Greek coasts than there are now, as several towns have taken the name of the seal. Phocis is the name of an ancient Greek district that stretched past Mount Parnassus to the Gulf of Corinth, and there is at the present time Foca at the north end of the Izmir Gulf, Turkey, and Foča, an inland town in Yugoslavia. Keller (1887) notes that very ancient pre-Darian coins (*ca.* 500 B.C.) show a picture of a seal, and that coins from Rhodes show a seal's head. He also mentions that etymologically the Greek work for " phoca " means the swollen or plump animal, and must have been first applied, though not in a taxonomic sense, to the monk seal.

Some of the later history has been summarized by Monod (1932). An Italian map of the fourteenth century shows an island between Lanzarote and Fuerteventura in the Canary Islands called Ya de Uegi marini—the island of sea wolves—to-day called more simply Lobos Island ; and in 1341 Niccoloso di Recco included seals in an inventory of the Canary Islands. In the fifteenth century Portuguese explorers found numerous bands of monk seals and killed many for their skins, and in 1434 Alfonso Baldaya started the industrial exploitation of the seals in the bay Rio del Oro, north of Cap Blanc. A traveller named Zarco reached Madeira in 1418 and named a small cove Câmara de Lobos because of the seals he found there. Rondoletius published his *Aquatilium Historia* in 1554 and included a drawing and a short Latin description of " de Vitulo maris mediterranei ", but the first specific name was given by Hermann (1779) who described an animal from the Dalmatian coast

and called it *Phoca monachus*. Buffon (1782) mentions that seals from the Adriatic were kept in captivity in France and Germany in 1760, and describes a female seal that was on exhibition in Nîmes in 1777. He also gives a detailed description of a male seal that was caught on 28th October, 1777, " off the island of Guarnero " in the Adriatic. He saw this seal in Paris in December, 1778, and from the similarity of his description of it and of its locality and habits it seems that it must have been the same animal described by Hermann—a fact which Cuvier noted as early as 1813. Hermann saw the seal in Strasbourg at the end of October and beginning of November, probably in 1778, and says that it was being taken on tour by a company of Venetians who were going to Paris to show it to the King. He mentions that the seal was said to have been captured in the autumn of 1777 in the Dalmatian Sea at Ossero. Ossero is on the island of Cherso in the Gulf of Quarnero, off the Dalmatian coast. Buffon notes that the seal died in August, 1779.

Since that time there have been many references, though mostly of the occurrence of single individuals. Cuvier (1813) describes a seal that was kept in captivity for two years in a very small bath, only a foot longer and two feet wider than the animal itself. In this remarkably small enclosure it spent 9–10 hours of each day in six inches of water that were drained off each night. The London Zoological Gardens has three times kept a monk seal for short periods. The first specimen, a young female, arrived in May, 1882, but died the same day ; the second was in 1894, when a young animal from Madeira lived there for three and a half months ; and the last was in 1910, when a second animal from Madeira lived for four months. In 1926 the American Museum of Natural History received skins and skeletons of three seals from the Desertas Islands ; these were believed to be the first Mediterranean seals in American museums. More recent references have again been concerned mainly with isolated occurrences, and there is at the time of writing a male monk seal from near Oran that has been in captivity for about two years in the Jardin des Plantes in Paris.

Distribution and abundance

The Mediterranean monk seal is known from the shores and islands of the Mediterranean and the western coast of North Africa (figs. 1 and 2). It has been recorded from : Gulf of Almeria, Spain ; Cabrera, Balearic Is. ; Toulon ; Corsica ; Cape Teulada and the Gulf of Cagliari in Sardinia ; the island of Pelagosa in the Adriatic ; the Gulf of Quarnero and Fort Opus in Yugoslavia along the Dalmatian coast ; the Gulf of Salonika in north Greece ; Cape Caliacra, and generally in the Black Sea and Bosphorus ; Tantoura ; El Arish ; Port Said ; the island of Galite off the Tunisian coast ; Oran ; Madeira and the Deserta Grande Islands ; the Canary Islands, and along the African coast, including Cap Barbas, Baie d'Etoile and Baie du Levrier, to Cap Blanc.

Budker (1945) says that the southern limit along the African coast is 20° 49′ N. (approximately the latitude of Cap Blanc), that its limit of distribution is influenced by the temperature of the sea and corresponds with the 20° C. winter isotherm. In the British Museum collections there is an Ascarid from a monk seal taken in Senegal

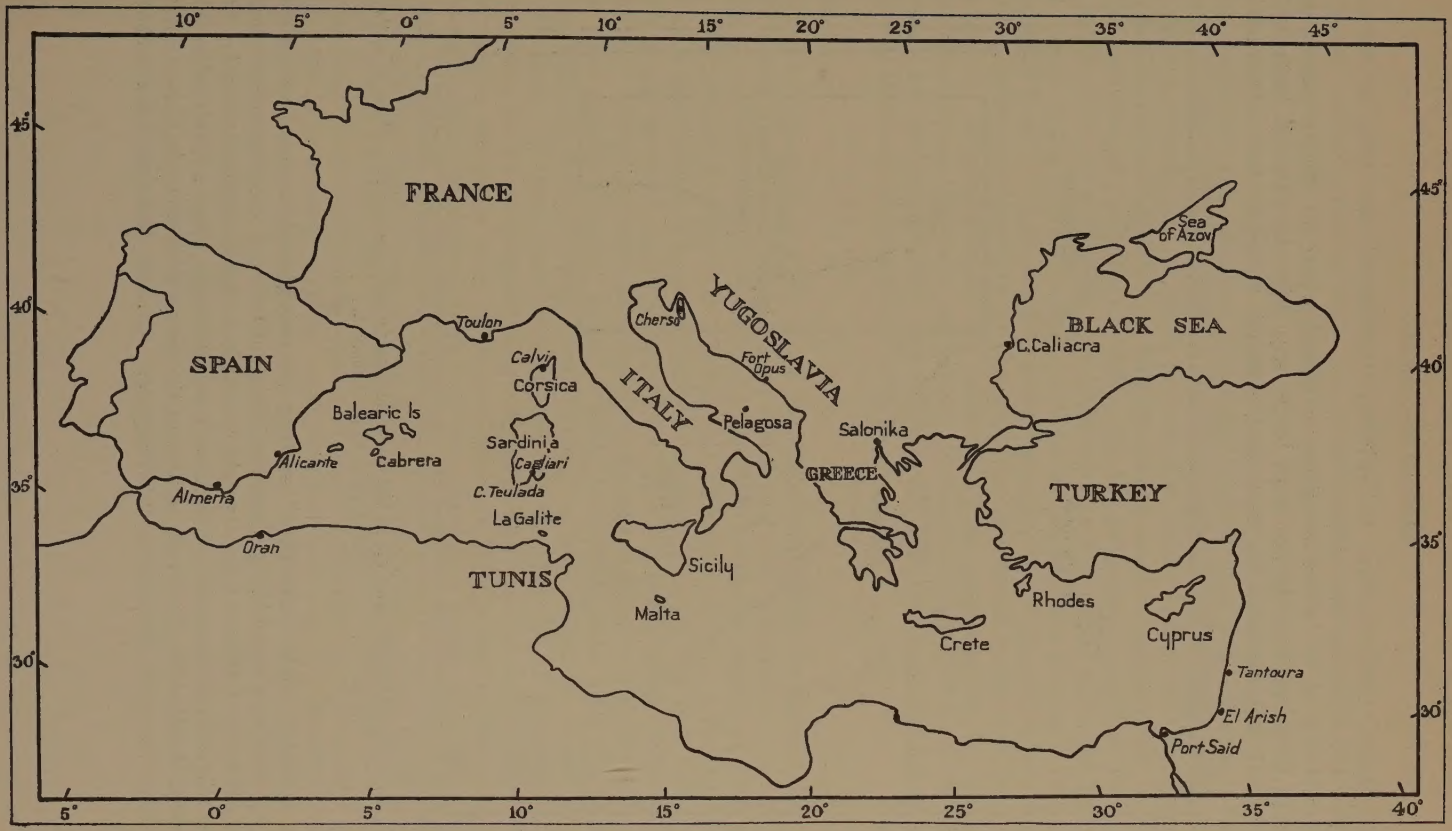

FIG. 1.—Map of Mediterranean region to show distribution of *M. monachus*.

(approximate latitude 15° N.). It has been in the Museum since 1863, but there is no other information about the host.

Apart from the few references given by Monod (1932) for the fourteenth and fifteenth centuries there do not seem to be any other accounts of large scale commercial exploitation of the monk seal, although during a visit to Madeira in

FIG. 2.—Map of Mauritanean coast and Atlantic islands, and inset of Cap Blanc to show distribution of *M. monachus*.

1945, Cadogan (1945) heard that " in 1943–4 a consignment of some twenty-five seal pelts had been seized by the Customs Officials at Funchal, and it was not thought likely that any further attempt would be made to commercialize them for the present ". Any commercial use of an animal necessarily implies its abundance in the area. Admiral W. H. Smyth, writing of the period 1810–1824 (in Flower, 1932) says that " between Alexandria and Benghazi . . . we found fish and seals in

abundance ", but from then up to the present day there have been references only to single animals or small groups. Barceló (1875) said that seals were very common on the shores of the Balearic Islands at the time he wrote, but Cabrera writing in 1914 notes their disappearance from these parts. Aharoni (1930) notes that the seal is quite often offered for sale by fishermen from Askalon and Jaffa. Bertram (1943) says that a seal was seen off El Arish in about 1941, and according to Monod (1945), Agacino (1950) and Postel (1950) there must still be reasonably large colonies along the western coast of Africa down to Cap Blanc. Sixty seals were seen by Postel just north of Cap Blanc, and twenty-one by Agacino along the coast of Rio de Oro, and Cousteau and Dumas (1953) note the presence of a herd of about two hundred seals at Port Etienne. An adult female was surprised and killed in a cave in Corsica in 1947 (Troitzky, 1953), and Butler (in litt.) saw a seal in the Gulf of Salonika in 1950. There is still a small breeding colony in the more isolated regions of the Desertas Islands, although the fishermen there regard it as an enemy to their livelihood. A recent report in *The Times* (11th June, 1954) says that the monk seal still appears yearly on the Turkish coast. The main stronghold of the monk seal at present seems to be along the coast of Rio de Oro, and if not molested it is probable that its numbers will be maintained there.

Taxonomy

The first specific description of the monk seal is that given by Hermann in 1779. He named as *Phoca monachus* a male animal captured at Ossero, on the island of Cherso, off the Dalmatian coast in 1777, and seen by him in Strasbourg. He gives a very detailed description of the seal and its habits, and also a drawing of the whole animal with details of the head and flippers (Pl. 4, A). In 1782 Buffon, not knowing of Hermann's work, described the same seal which was, in 1778, on show in Paris. He gives a very good drawing of the animal (Pl. 4, B) but only refers to it as " Le phoque à ventre blanc ". These two descriptions form the basis of practically all the succeeding names which have been applied to the monk seal.

Boddaert, in 1785, used Buffon's paper as the basis for his very brief Latin description of *Phoca albiventer*, a specific name which was in use for many years. In volume two of the third edition of Pennant's *Quadrupeds*, published in 1793, Pennant gives a description of the Pied Seal, mentioning Buffon, but adding " This I saw at Chester ; it was taken near that city in May, 1766 ". It is difficult to know whether Pennant was applying Buffon's description to a seal actually taken near Chester, Cheshire, in which case it was very unlikely to have been a monk seal, or whether he was confusing the name with Cherso on the island of that name in the Adriatic. The drawing he gives is not very good, (Pl. 4, C) and shows an animal with a broad white ring round its neck and a white spot behind one flipper, the rest of the body being black. Pennant also describes the Mediterranean seal, quoting Hermann, but giving no picture. Shaw in 1800 uses Pennant's Pied Seal and Buffon's Phoque à ventre blanc for his *Phoca bicolor*, and used *Phoca monachus* for the Mediterranean seal. He uses the drawings previously given by Buffon and Pennant and labels both of them " Pied Seal var,"

In a brief footnote, in which he quotes a passage from Buffon, Peron (1816) uses the name *Phoca leucogaster*, and in another equally brief footnote Fleming (1822) first suggests the use of the generic name *Monachus*, " Some seals, as *Ph. monachus*, are said to have four incisors in each jaw. Such will probably be constituted into a new genus, under the title *Monachus* ". In 1824 Cuvier suggested *Pelagios* as a new generic name for *Phoca monachus* Hermann, a name which has given rise to many variants ; Cuvier himself in 1826 called it *Pelagius*, McMurtrie (1834) used *Pelagus*, and Gray (1837) used *Pelagias*. Lesson in 1828 renamed Hermann's species *Phoca hermanni*, and Nilsson in 1838 called it *Monachus mediterraneus*. In 1841 Gloger called the monk seal of the Mediterranean *Pelagocyon monachus*, and in 1848 Menis used the name *Phoca crinita* for an animal presumably from the Adriatic (book not seen). Gistel, also in 1848, proposed the generic name *Rigoon* instead of *Pelagios* of Cuvier. Giebel (1848) linked the monk seals with the southern Phocids under the genus *Leptonyx* and the subgenus *Leptorhynchus*. This part of his classification is given here in full :

" *Leptonyx*

a. Stenorhynchus
   1. L. serridens
   2. L. leopardinus

b. Leptorhynchus
   3. L. weddellii
   4. L. rossii
   5. L. monachus."

The last synonym was given by Gray in 1854, when he named the new genus and species *Heliophoca atlantica* on the skin and skull of a young animal from Deserta Grande, Madeira. The skull and stuffed skin of this animal are now in the British Museum collections (Reg. No. 1853.10.6.4, 1063a.)

Description

Fully grown adults are about 8–9 ft. long. Gavard (1927) gives the length of a female which had produced a pup as 2·42 m. (7·9 ft.), but does not say whether this length included the hind flippers or not ; Troitzky (1953) gives the nose to tail length of an old female as 2·78 m. (9·1 ft.), and both Postel (1950) and Agacino (1950) note that the biggest animals that they saw were about 3 m. (9·8 ft.) long. Monod (1945) gives the length of a male animal as 2·9 m. (9·5 ft.). Of the two adult skins in the Museum collection the length of the male is 2·38 m. (7.8 ft.) and of the female 2·1 m. (6·9 ft.). These measurements are from nose to tip of tail, but should be regarded with caution as that of the male was taken from a rather crumpled dressed skin, and that of the female from an undressed but folded skin. The weight of the female seal measured by Gavard was 300 kilos (661 lb.), and that measured by Troitzky was 302 kilos (666 lb.) without the viscera.

There is a certain amount of variation in the colour of the adult seal. Gavard says that it is all black except for some patches, particularly a large one of a dirty

white colour round the navel, and some little yellowish patches on top of the head. Agacino (1950) notes that the seal is spotted ventrally, but that there is some variation in colour and the old male may be a silvery colour all over. The light yellowish beige colour of the female described by Troitzky was also probably due to age. Cousteau and Dumas (1953) saw a large white bull in one of the caves on the islands of La Galite, but this may have been the silvery colour of old age. The monk seal now in the Jardin des Plantes in Paris is thought to be an adult animal and is chocolate brown dorsally shading to greyish fawn ventrally. It did not appear to have a white ventral patch but had several whitish scar marks along the back. An examination was made of the few skins of this species in the British Museum collections. The dressed skin of a fairly young male animal, length from nose to tip of tail 1·75 m. (5·74 ft.) (1894.7.27.3, 1063h), is dark blackish brown dorsally, with a slightly yellowish appearance due to the yellow tips of the dark brown hairs. This shades to light brownish yellow ventrally, but without a light ventral patch. The skin of an adult male (length 2·38 m., 1890.12.30.1) is generally dark blackish brown, slightly yellowish along the centre of the back and belly due to the yellow hair tips. In the centre of the belly, slightly nearer the fore flippers than the tail, is a roughly diamond-shaped patch of dirty yellow colour, about 73 cm. long and 58 cm. wide. The whole of the skin, particularly under the chin, the sides of the neck and the centre and hinder region of the back, is covered with irregularly placed streaks and spots of yellowish hair. These marks show on the under surface of the prepared skin and may possibly be due to scars. The skin of the adult female (length 2·1 m, 1894.7.27.2, 1063g) is more like the young animal than the adult male. It is dark blackish yellow dorsally, the hairs being dark brown with yellowish tips. This shades to light greyish yellow ventrally, and there is no light ventral patch. The back shows a few light scar-like streaks similar to those found on the male. These whitish streaks were also noticed on the seals examined by Hermann and Carruccio (1893); they are found on both sexes. The white ventral patch seems to be irregular in its occurrence.

The hairs of the adult are very short and bristly and lie close to the body. They are approximately half a centimetre long. The appearance of the young seal before it moults its natal coat is described from the youngest skin in the Museum collections (1892.11.7.1, 1063l). The length of the skin from nose to tip of tail is 1·4 m. (4.4 ft.). Dorsally it is a rich dark brown, shading at the level of the fore flippers to a lightish brown ventrally. On the belly, slightly nearer the fore flippers than the tail, is a roughly diamond-shaped patch of a dirty yellowish colour with a few very small light brown spots on it. The patch is approximately 34 cm. long and 28 cm. wide at its widest point. There is a small light brown area along the upper lip, and the whiskers are also light brown and oval in cross section. The texture of the hair of this young seal is quite different from that of the adult. It is soft and woolly, the hairs are 1–1½ cm. long and do not lie close to the body as they do in the adult.

The whiskers range in colour from light yellow to brown; they are smooth, not wavy as in *P. vitulina*, and oval in cross section. Nails are present on both fore and

hind flippers. That on the first digit of the fore flipper is about 2·54 cm. (1 in.) long, and the others decrease slightly in size towards the fifth digit. The nails on the hind flippers are very small and inconspicuous. The tongue has a notch in its anterior end.

Lobstein (1817) described in some detail the anatomy of the viscera of a female seal that died in Strasbourg in 1815 after touring France and Germany for two years and Troitzky (1953) gives a brief description of the viscera of a full term foetus, but the most detailed recent investigation into the internal anatomy of *M. monachus* was done by Dieuzeide (1927) on a young male seal that was captured near Oran in December 1926, and which lived for a few months in the Experimental Station at Castiglione, Italy. A brief summary of the results, taken from Dieuzeide unless otherwise noted, is given here for completeness. The length of the male animal was 1·68 m. (5·5 ft.) from nose to tip of tail, and of Lobstein's female 2·13 m. (7·0 ft.). The oesophagus which lay mainly to the left of the trachea and large blood vessels was 60 cm. long and 4 cm. in diameter and was very dilatable. The oesophagus of the adult female (Lobstein) was 97 cm. long, the small intestine 14·5 m. and the large intestine 1·3 m. The whole alimentary canal was 17·5 m. (5·74 ft.)—eight times the length of the animal. There was no definite line of demarcation between the oesophagus and the stomach, which looked more like a dilatation of the oesophagus. The height of the stomach was about 25 cm., its width about 12 cm. and it led into the small intestine, which had a length of 12 m. and a diameter of 3–3½ cm. The caecum was a small pocket and the large intestine measured a metre in length by 4 cm. in diameter. The liver was large, measuring 40 × 40 cm. and consisted of six long pointed lobes. There was a large venous sinus (a dilatation of the inferior vena cava) and the round ligament (the remains of the umbilical vein) was well represented. The gall bladder was multilobulate and when full measured 13 × 13 mm. The left lung was the larger, weighing 950 gm., while the right weighed 850 gm. The kidneys were two oval masses, the right anterior to the left, with a combined weight of 1 kg. 140 gm. They were lobed and had an extensive vascular network. The left renal vein was large and of practically the same diameter as the vena cava. It was formed from the union of three large vessels and the superficial plexus of the kidney. On the right side the vena cava followed the inner border of the kidney and received vessels from it. The right kidney was supplied from the aorta by two renal arteries which arose a little anterior to the one going to the left kidney. The suprarenals were small and almond shaped, measuring 33 × 14 mm. The bladder was very thick (9 mm.) and measured 15 × 4 cm. The prostate was reduced and the testes were internal, measuring 4 × 1.5 cm. The penis was 8 cm. long and the baculum 7.8 cm. long. The heart was oval in shape, and Dieuzeide gives a detailed description of its anatomy.

Several species of parasites have been recorded from the stomach and intestine (Joyeux and Baer 1936, Baylis 1937, Markowski 1952). There are two Nematodes—*Contracaecum osculatum* (Rudolphi 1802) and *Porrocaecum decipiens* (Krabbe 1878), and four species of Cestode—*Diphyllobothrium coniceps* Linstow 1907, *D. elegans* (Krabbe 1865), *D. lanceolatum* (Krabbe 1865) and *D. hians* (Diesing 1850).

Remarkably little information is available about the breeding habits of this seal. Practically all that is known is in a recent paper by Troitzky (1953). In this she mentions that after a gestation period of eleven months the pups are born on land in September and October and are fed by the mother for six or seven weeks. The female has four teats on the posterior part of the abdomen and lies on her side when feeding the pup. At the end of this time the pup moults its woolly coat and enters the water for the first time. Troitzky says that the young seals stay with their mothers for three years, that they do not begin to breed until they are four years old, and that mating of the adult animals takes place about seven or eight weeks after the birth of the pup. The sum of eleven months' gestation plus seven or eight weeks before mating makes a total breeding cycle of thirteen months, and although it is usual in most Phocids for the female to bear a pup at the same time every year, Troitzky says that this seal only has a pup every alternate year.

Apart from Troitzky's paper, most of the information about breeding times has to be inferred from records of still born pups, foetuses and young animals. Dathe (1934) records that a young female seal was caught on 19th September, 1933, on the Dalmatian coast. The umbilicus was not yet healed and the animal was thought to be only a few days old. Its length was approximately 90 cm. and it weighed 26 kilos. This little animal was kept in captivity and was going to be taken to Frankfurt Zoological Gardens. It was fed by bottle six or seven times a day on a mixture of half gruel and half milk with a little cod liver oil and freshly rubbed fish paste. On 26th September it was taken to Split, preparatory to moving to Frankfurt, but the journey re-opened a wound on its stomach, caused probably by a fish hook, and on 29th September it died, its length then being 1.20 m.

Carruccio (1893) notes that a foetus 50 cm. long was taken from a pregnant female on 21st May, 1891, and Gavard (1927) mentions a captive female that produced a still-born pup on 14th April, 1926. This pup weighed 2.25 kilos and measured 62 cm. Both these foetuses are of such a size that they would have been full term and born about September, and it is strange that Postel (1950) should say that the pups are born in the spring. Agacino (1950), who went to Las Cuevecillas, Rio do Oro on 26th December, 1945, says that at that time the smallest seals were 1.5 m. long, and that a mother was seen to be feeding her pup. This must have been a pup born very late in the season, probably about the middle of November.

The voice is said to be a sharp strong cry from the bottom of the throat (Cuvier, 1813), while Agacino (1950) says that when they are annoyed they make a noise like a wounded dog. Hermann said that the one he observed had a voice like that of a hoarse dog and that sometimes it would howl. This seal could not tolerate dogs, and would try to drive them away by clapping its teeth. The seals kept in captivity have all been noticeably intelligent and docile animals. They have become attached to their keeper and would recognize him, follow him about, and even obey his orders to a certain extent.

The feeding habits, as observed in captivity, are very interesting. The animal described by Hermann ate about 14 pounds of fish daily and in order to stress the expense of keeping it, inquisitive spectators were told that it ate only the best fish,

such as eels and trout. It did occasionally receive eels and carp, if paid for by the spectators, but usually it had whiting. It took the fish either out of the keeper's hands or caught them in its tank, but preferred to eat them in water. It seized the fish by the head, squeezed and shook them a few times and then swallowed them whole. Often intestines of the fish were found in the water, and although the keeper thought this was done deliberately, Hermann suggested that the insides of the fish came out accidentally when it was squeezed. Buffon saw the same animal while in Paris and said that there it was fed mainly on carp and eels, preferring the latter. The fish were sprinked with salt, the eels eaten whole, but the carp were crushed with the teeth, let fall and then the belly of the fish ripped open and the entrails removed. The fish was then seized by the head and swallowed. Cuvier also notes that the entrails were removed and the fish swallowed head first. The seal at present in Paris was also seen to swallow its fish head first, and this has also been observed in *Halichoerus grypus* and *Phoca vitulina*. Indeed it seems possible that this method might be the normal one for Pinnipeds generally, as it would avoid any injury to the seal by the backwardly projecting fins, scales and spines of the fish. Two female seals described by Gavard (1927) also disembowelled their fish unless they were very small, and also were unable to pick the fish off the ground, and could eat them only in water. They ate sardines, bonito and octopus—about 12 kg. a day. Boettger (1951) notes that native fishermen along the African coast say that the seals eat fish and lobsters (*Palinurus*), and remains of fish of the genera *Dentex* and *Labrax* have been found in the stomach of a seal captured off Sardinia (Carruccio 1893). A monk seal in the Gulf of Salonika was seen to be playing with a large fish, tossing it into the air and catching it again (Butler in litt.)

Troitzky (1953) describes an adult female seal that was killed in a cave on Corsica in September, 1947. It was found to be pregnant and a full-term foetus was removed, but could not be revived. The pup, a female, was 120 cm. long and weighed 17 kilos. It was dark, greyish black colour, with a white ventral patch. Troitzky notes that the pup in its colouring did not differ from descriptions of what she regarded as "typical" *M. monachus*, but says that the mother was not so. She observes that in its dentition, its great size, and the time of breeding the adult resembles *M. monachus*, but the shape of its head with a long snout, the light colour, the absence of the white ventral patch, and the second digit of the fore flipper longer than the first are characters not associated with that species. After reviewing other members of the Phocidae she comes to the conclusion that these characters are more like those of Arctic Phocids, and says that the most logical conclusion is that this female is a hybrid, the result of a cross between a monk seal and, probably, *Phoca groenlandica*, and that it is interesting that such a hybrid should have been able to produce a pup.

It is considered extremely unlikely that such a cross could have taken place. *Phoca groenlandica* and other members of the Arctic Phocidae have not been recorded from the Mediterranean in Recent times, and indeed, they seldom occur south of Arctic latitudes. From the description of the teeth—worn, broken and diseased—it is assumed that the animal was old, and the light colouring was probably also due

to age. The white ventral patch is not of universal occurrence amongst the monk seals. It is not possible to comment on the other two characters, from lack of exact information, but from the photograph of the adult seal, as far as it is possible to see the shape of the fore flipper does not appear to be unusual and the drawings and photograph of the skull do not appear to differ in any way from undoubted skulls of *M. monachus* in the Museum collection.

II. *Monachus tropicalis*

History

The first reference to the monk seal of the West Indies is that given in the account of the second voyage of Columbus. At the end of August, 1494, the ship anchored by the rocky island of Alta Vela, south of Haiti (= Hispaniola), and the men that went ashore killed eight " sea wolves " that lay sleeping on the sand (Kerr, 1824). The next record chronologically, and the first for Florida, is that of Herrera who, while describing Ponce de Leon's discovery of the Dry Tortugas Islands (lat. 24° 10′ N. long. 83° 55′ W.) on 21st June, 1513, said that a foraging shore party took fourteen seals (Moore 1953). Du Tertre (1667) was told by Brother Charles Poncet, who had been to Guadeloupe, that he had seen at least twenty asleep under the trees near the shore, and many of them were killed. Dampier (1705) noted that there were seals on the Alacrane Islands in 1675, Sloane (1707) saw them on the Bahama Islands in 1687, and Olafsen (1774) makes a reference to the seal of the Antilles. Hill (1843) gives a description of a young seal from Pedro Kays, and Gosse (1851) published an account of a voyage in 1846 by Mr. George Wilkie to Pedro Kays, where he saw several seals and killed a few. It was on this voyage that the type skin of *Phoca tropicalis* was obtained. In 1883 the U.S. National Museum received a mounted skull and skin from a female seal captured off Cuba earlier in the same year and presented by Prof. Felipé Poey (True and Lucas, 1885). In 1886 H. L. Ward and Prof. F. Ferrari Perez of the Mexican Geographical and Exploring Survey set out from Campeche to the Triangles to search for *Monachus*. (Ward, 1887b). Although they were only on the islands from 1st to 4th December, forty two specimens were taken away and shared between the two members of the expedition. Of the specimens retained by H. L. Ward a complete articulated specimen (1887.8.5.1), and a skin and skull (1889.11.5.1) are now in the British Museum (Natural History), and an articulated specimen (899c) is in the Cambridge Zoological Museum. These last two specimens were purchased from Ward by F. D. Godman of Cambridge. A recently born pup was taken back to Campeche, but it lived there only a week. A female seal was captured at the Triangles in 1897 and lived for nearly 5½ years in New York Aquarium, where it died in 1903. (Anon 1903). E. W. Nelson and E. A. Goldman, during their biological investigations of Mexico from 1892 to 1906 (Goldman, 1951), spent the period 18th to 23rd June, 1900, on the Triangles. Their main object there was to obtain specimens of seals, but apart from remarking that " in quest of these animals we were very successful ", no mention is made of their abundance, or how many were killed. The New York Aquarium received four more

seals—an adult male and three yearlings—in June, 1909 (Townsend 1909). These were obtained from a dealer in Yucatan who presumably got them from from the Triangles or the Alacrane Islands. Several seals were seen on the Tortugas Islands during the period 1903–8 and two were kept in a moat for some time, where they became fairly tame (Moore, 1953). Six seals were captured by a fishing vessel in 1915 and taken to Pensacola, where they were kept in captivity for some time and then turned loose, when bathers in the area objected to their presence (Allen 1942). Townsend (1923) notes that a seal was killed near Key West, Florida in March, 1922. Gunter (1947) gives sight records of seals along the Texas coast in 1926 and 1932, and Lewis (1948) says that a young seal was killed at South West Kay in the Pedro Group in 1939. A. C. Wheeler (in litt.) saw two seals on the beach of Drunken Man's Cay, about two miles south of Kingston, Jamaica in November, 1949.

Distribution and abundance

The West Indian monk seal was at one time abundant in the Gulf of Mexico and off the islands in the Caribbean Sea (Fig. 3.). The presence of numerous Seal Cays and Islands and Lobos Cays show how widely the seal was distributed in the area.

1. Seal Cay, south of Long Island, Bahamas. lat. 22° 38′ N., long. 75° 54′ W.
2. Seal Cay, south of Caicos Bank, Bahamas lat. 21° 10′ N, long. 71° 47′ W.
3. Seal Island, north of Anguilla, Leeward Is, W. Indies lat. 18° 24′ N., long. 63° 20′ W.
4. Cay Lobos, north of Cuba, lat. 22° 25′ N., long. 77° 36′ W.

and Allen (1887*a*) gives the following :

5. Seal Keys—on the coast of Honduras in about lat. 16° N., a few miles north-east of the Mosquito Coast.
6. Seal Key—about 200 miles further south along the same coast in about lat. 12° 40′ N.

It has been recorded from the Bahama Islands ; Key West, Florida ; Galveston Bay and Brazos, Texas ; the Triangle Islands to the west of Yucatan, lat. 20° 55′ N. long. 92° 12′ W. : the Alacrane reef to the north of Yucatan, lat. 22° 32′ N., long. 89° 45′ W. ; the shores of Cuba and Jamaica ; the Pedro Kays to the south of Jamaica, lat. 17° N., long. 77° 30′ W. ; Alta Vela, a rocky island south of Haiti ; and Guadeloupe.

That the seal has formerly been abundant is evident from some of the earlier accounts. Dampier (1705) said of his visit to the Alacranes in 1675 : " Here are many seals . . . the Spaniards do often come hither to make Oyl of their Fat ; upon which account it has been visited by English-men from Jamaica, particularly by Capt. Long : who having the Command of a small Bark, came hither purposely to make Seal-Oyl." Sloane (1707) gives the following account of the seals of the Bahamas, " The Bahama Islands are fill'd with Seals, sometimes Fishers will catch one hundred in a night. They try or melt them, and bring off their Oil for Lamps to these Islands." In 1856 a Mr. Alexander was on the Triangles and saw only two

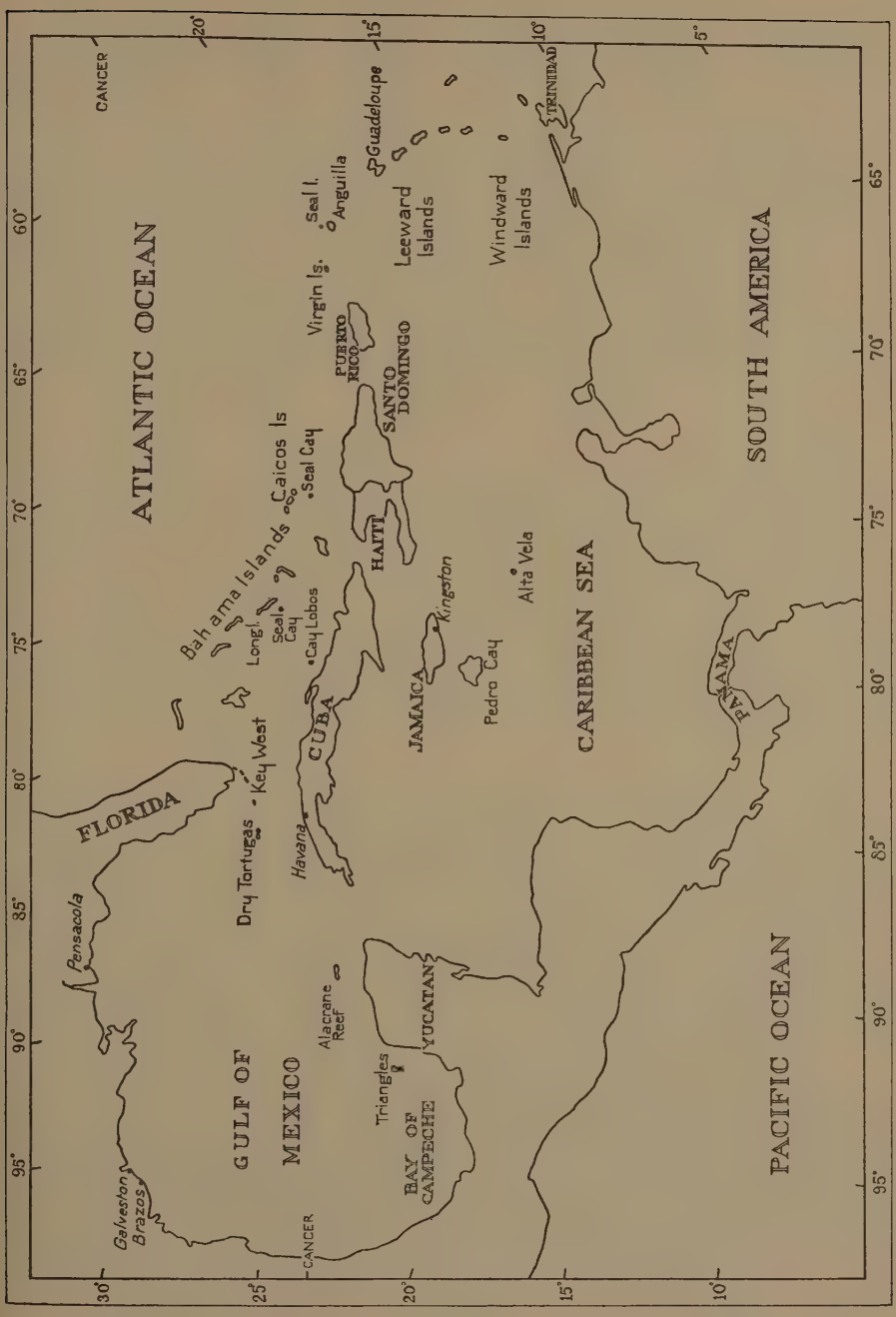

FIG. 3.—Map of Caribbean region to show distribution of *M. tropicalis*.

living seals, but remains of skeletons and hides indicated a once flourishing business ; and although H. L. Ward does not say exactly how many he saw in 1886, there must have been quite a large colony as he killed over forty animals (Ward, 1887*b*). Allen (1887*a*) suggested that at the time of his writing seals were still present on the islets of Salt Key Bank, north of Cuba, the isles off Yucatan, and probably the isles between. In 1897 at the time of the capture of the seal for New York Aquarium about thirty were observed on the Triangles (Anon 1903), but as late as January, 1911, according to Lewis (1948) about two hundred seals were killed in this locality and at the time his paper was published he thought that there were perhaps still a few left there and on the South West Kay in the Pedro Group. In view of the fact that seals have been seen as recently as 1949 near Jamaica, and that Moore (1953) quotes a " well informed and responsible friend " who knows of the whereabouts of seals somewhere within their former range, it seems likely that a remnant of this species is still living.

Taxonomy

During Mr. George Wilkie's visit to the Pedro Kays in 1846 (Gosse, 1851) he obtained the skin of a monk seal which he gave to Gosse. Gosse sent this skin, which had no bones with it, to the British Museum where J. E. Gray published a description of it under the name *Phoca tropicalis* Gray, 1850. This skin has been stuffed and is in the Museum collection (Reg. No. 1847.2.2.2). Gosse (1851) republished the description of the seal given by Hill (1843), and in a footnote on p. 308 suggested the specific epithet " *wilkianus* ", but he gave no generic name, and moreover, was already antedated by Gray. In 1866 in the *Catalogue of the Seals and Whales in the British Museum* Gray repeated the descriptive paragraph he gave in 1850, but used the name *Monachus tropicalis*.

Description

The nose to tail length of an adult male animal is between 7 and 8 ft., females being in general slightly smaller. Townsend (1906) gives the length of an old female with very worn teeth as 9 ft., but he was probably measuring to the tips of the hind flippers. The nose to tail lengths of both the skeleton in the British Museum, (probably a female) and that in Cambridge, (sex unknown) are both about 7 ft. 3 in. The nose to tail length of a dressed skin of an adult male (1889.11.5.1, 1064b) is 7 ft. 5 in., and Ward (1887*b*) gives nose to tail lengths of two pregnant females as 7 ft. 1 in. and 6 ft. 6 in. A female measuring 6 ft. 11 in. to the tip of the hind flippers and which had been in New York Aquarium for $5\frac{1}{2}$ years weighed 360 pounds at death. This seal died from fatty degeneration of the heart, liver and kidneys, so presumably a healthy animal of this size would weigh less.

Ward (1887*b*) gives the following description of the colour of the adult seal : " Adults are grayish brown or grisled on the back, a result of the Vandyke-brown hairs being tipped with light horn-color, the lower surface ochreous yellow to yellowish white. Females seem to have much less of the yellow or white on the ventral surface. From the black pelage of the extremely young to that of the adult

there is an intermediate stage of yellowish gray on the dorsal surface, shading to almost a perfect ochre on the ventral portions." This is the most reliable account of the colour, and corresponds well with that of the stuffed specimen in the Museum, which is the type of *Phoca tropicalis* Gray. This animal is dark brown, and slightly lighter on the sides and belly. The hairs of the back are dark brown with a lighter tip, while those of the sides and belly have a more yellow tip. The hairs lie close to the body and are extremely short, the longest—those on the sides—being about 1 cm. long. A dressed skin of an adult male from the Triangles in the Museum collection (1889.11.5.1, 1064b) is dark blackish brown all over, with a slight yellowish tinge due to the yellow tips of the hairs. New born pups are black in colour and the hair is long, soft and woolly.

The whiskers are yellowish horn colour, some being slightly darker at their bases. Those of the Museum specimens are oval in cross section. Nails of appreciable size are present only on the fore flippers. That on the first digit is about an inch long, those on the remaining four digits decreasing gradually in size. The nails of the hind flipper are very small.

The description of the eye is given by Ward (1887*b*) : " The pupil is medium sized, round, and well defined, the iris is light reddish brown in color, and with but little of the sclerotic coat showing. Over the cornea there appears a deadening film . . .", which he attributes to the strong reflection of the tropical sun from the coral sands.

Young animals are born about the beginning of December. Ward (1887*b*) was on the Triangles from 1st to 4th December and killed five females with full-term foetuses, and noticed another female with a new-born pup. The female has four teats. One of the foetuses measured 85 cm. from nose to tip of tail, was covered in black woolly hair and had black whiskers. Measurements of the skull and skeleton of this pup as well as those of adult animals collected by Ward are given by Allen (1887*a*).

Ward examined the stomach contents of several animals, but found only fluids and large numbers of intestinal parasites several inches in length. Gosse (1851) recorded the opinion of the " more experienced fishermen ", who said that the seals fed " as generally on molluscous animals as on fish ", but there is no proof of this. The animal noted by Hill (1843) lived for four months in captivity, without eating, and when it died " the fat was four inches thick and yielded four gallons of oil ". The skull of this animal, which was then, as Hill (1846) says " an undescribed Seal ", was exhibited at a meeting of the Zoological Society of London in September, 1846. Unfortunately it has not been possible to trace this skull, which was probably the first specimen of the West Indian monk seal to reach this country, arriving here shortly before the skin sent by Gosse which became the type.

The West Indian monk seal appears to be a fairly noisy animal. Hill (1843) said that his young animal " grunted, barked, growled and snarled like a dog ", and Ward (1887*b*) said that the voice of the young was " a long drawn out guttural ' ah ' with a series of vocal hitches during its enunciation ". Townsend (1909) also noted that it was noisy, and the young often roared harshly.

On land at least the seal seems to be rather lethargic. Ward (1887*b*) notes that unless the seals were approached closer than three or four feet they showed no interest or alarm. Closer than that they would rouse themselves, bark, and move off a little. When Ward and his party attacked a group of seals they got more excited and would make savage rushes, and would then fall back on their dead fellows and bite and shake them. Nevertheless, as Ward notes " the whole aspect of the animals was one of indecision . . . they only roused themselves to action on being individually attacked ". This behaviour is not peculiar to the monk seal, but seems to be common to all seals. Ward also notes the peculiar circumstance that several of the animals he collected had a growth of minute algae upon their backs and flippers, especially the hinder ones, so that they appeared quite green.

Although Ward says they are neither curious nor playful, Hill (1843) notes that the young specimen he kept in captivity was lively, and those kept in New York Aquarium were certainly playful. The two which were received in 1897 had the habit of filling their cheeks with water and squirting it at visitors, while the seal which arrived in 1909 amused itself by tossing flipperfuls of water into the faces of visitors.

III. *Monachus schauinslandi*

History

The Hawaiian or Sandwich Islands are a chain of small islands near the centre of the North Pacific Ocean between 18° 55′ and 28° 25′ N., and 154° 48′ and 178° 25′ W. (Text-fig. 4) ; Honolulu on the island of Oahu being 2,100 miles S.W. from San Francisco and 3,445 miles S.E. from Yokohama. The chain stretches 1,578 miles from E.S.E. to W.N.W. All the islands are uninhabited, except Midway which is a transpacific cable station and sea plane base administered by the U.S. Navy, and Niihau, Kauai, Oahu, Molokai, Maui and Hawaii. The entire chain forms the Hawaiian Islands Bird Reservation.

Perhaps owing to the remoteness of the islands on which they live, there are very few references to the Laysan monk seal. In the early part of the nineteenth century seals must have been numerous as Bryan (1915) records that in 1824 the brig " Ainoa " set out from Hawaii on a sealing voyage in that area, and in 1859 the " Gambia " returned to Honolulu with 1,500 seal skins and 240 barrels of seal oil, some of which was probably from Midway Id., which was discovered on this trip. In 1893 a Mr. J. J. Williams visited Laysan and heard of an earlier expedition that had killed sixty or seventy seals on the island (Atkinson and Bryan, 1913). In 1905 Matschie published a description of a seal skull brought back from Laysan by Dr. H. Schauinsland, and named it after him. The U.S. revenue cutter " Thetis " returned in 1912 after a cruise to Midway and Laysan and brought back a seal skin which was presented to the Bishop Museum in Honolulu (Bryan, 1915) and parts of three others which are in The U.S. National Museum. Thirty five seals were seen on Pearl and Hermes Reef in 1913 (Atkinson and Bryan 1913), and Dr. Wetmore, who visited the area with the U.S.S. " Tanager " Expedition in 1923 saw a number of seals and collected ten for the U.S. National Museum (Bailey, 1952). In 1940 about

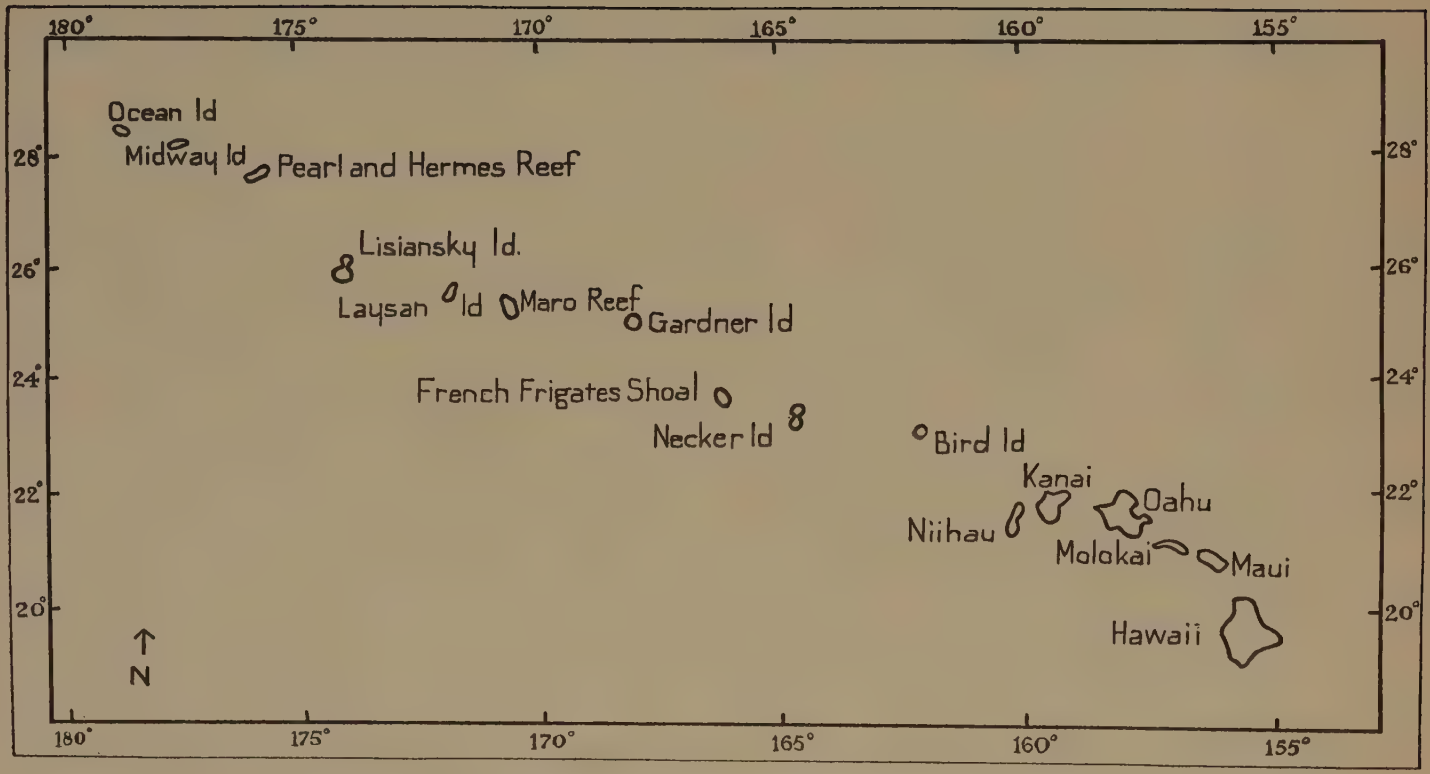

FIG. 4.—Map of the Hawaiian or Sandwich Islands to show distribution of *M. schauinslandi*.

half a dozen were seen round Midway (Blackman, 1941) and records of visits to the islands in 1949 and 1951 show that quite large numbers were seen resting on the beaches. The first, and it is believed, the only seal of this species to be kept in captivity outside the Hawaiian Islands was a young animal which was presented to San Diego Zoo by the Honolulu Zoo in 1951 (Anon, 1951). It was captured on French Frigates Shoal but only lived about three months in captivity.

Distribution and abundance

The Laysan seal has been recorded from the following of the Hawaiian islands : Ocean Island, Midway Island, Pearl and Hermes Reef, Lisiansky Island, Laysan Island, French Frigates Shoal, and a stray animal has been recorded from the coast of Hawaii, although they do not generally appear to go so far eastwards.

In 1824, 1859 and 1893 the seals were obviously very numerous, although in Schauinsland's own account of his visit to Laysan (Schauinsland, 1899) he only mentions that " seals come singly, indeed very seldom by the island ". In 1912, Elschner (1915) who was also on the " Thetis " during its trip, noted that there were many seals on French Frigates Shoal and Pearl and Hermes Reef. Also on the latter island thirty five seals were seen in 1913 (Atkinson and Bryan, 1913). The U.S.S. " Tanager " Expedition sailed from Honolulu in April, 1923, for a visit to the Hawaiian Islands. The *Bulletin of the Bishop Museum* in Honolulu (Bull. 10, 1924) only mentions that several seals were seen on Lisiansky on this voyage, and that two skins and skulls were collected ; Allen (1942) however, notes that Dr. A. Wetmore while on this expedition saw colonies of seals on Pearl and Hermes Reef and on Ocean Island, and estimated the total population to be about four hundred, and Bailey (1952) notes that he brought back ten specimens for The U.S. National Museum. Sixty eight seals were seen on Pearl and Hermes Reef in 1930, and five on Laysan in 1936 (Bailey, 1952), and Blackman (1941) who stayed for six months on Midway in 1939–40 saw about six seals. More recent visits to the islands (Bailey, 1952) show that the animals are still fairly numerous there. About thirty were seen on Laysan and over a hundred on Midway. A count of seals made in 1951 showed a total of 407 on the beaches, the largest populations being on Laysan (119) and Pearl and Hermes Reef (180). The others were seen on French Frigates Shoal, Maro Reef, Lisiansky and Midway. It was suggested that the large numbers on the beaches could perhaps be accounted for by the presence of tiger sharks in the water.

The monk seals are distinctive in being the only truly warm water form of Phocid, with the exception of the northern elephant seal (*Mirounga angustirostris*). So far as the distribution of the three species is concerned it is not difficult to accept the occupation of the West Indian islands from a source in the Mediterranean and along the Mauritanian coast, as the Canary Current passing down the latter coast would bear the emigrants to the eastern limit of the North Equatorial Current sweeping due west to the Caribbean Sea. The extension of the range of the genus to Hawaii and across the Isthmus of Panama is feasible when it is accepted that Phocids are capable of considerable overland journeys. For example Hayes (1928, p. 106) records that Captain Scott, when in the Antarctic, found seal carcases as far as fifty miles inland

and 5,000 ft. above the sea. The Isthmus of Panama at its narrowest is much less than fifty miles, and its lowest height above sea level less than 200 ft. If rivers were exploited by the seals the distances travelled overland might have been still further diminished. The North Equatorial Current in the Pacific could well have borne the animals to the islands they now occupy. Allen (1942) suggests that the colonization of the Pacific by the monk seal was from the West Indian stock in Tertiary time, when there was a waterway connecting the Atlantic and Pacific.

Description

Of the few records available only those of Matschie and Bailey (1952) give any information about the external features and Bailey includes some excellent photographs. A male, probably not full grown, collected by the " Thetis " measured 5·7 ft. from tip of nose to tip of tail, and a female 7·5 ft. Matschie gives the following description : " A scalp which I have for examination has very short, thick, bristly hair, loam coloured, with a silky shine. The lips are yellow-gray, and it is somewhat brownish on the front side of the neck. Most of the whiskers are light horn coloured, a few dark brown, and all with very thin points. The sides of the body of the stuffed animal in Bremen Museum are lighter than the back, the breast and stomach are whitish." Bailey notes that the underparts are light straw yellow and the back is dark slate grey.

While on the " Tanager " Expedition Dr. Wetmore examined the stomachs of seals for parasites. All the seals had abundant nematodes in the stomach and Chapin (1925) has described these as a new species *Contracaecum turgidum*. Cestodes, *Diphyllobothrium hians*, were also found.

The birth of the young seals evidently takes in January. The " Thetis " saw pups at this time in 1912, and one was born during the visit of Governor Frear to Pearl and Hermes Reef in January, 1913 (Atkinson and Bryan, 1913). The young male seal that lived in San Diego Zoo for a short time (Anon, 1951) was received in May and died probably at the beginning of September. It was therefore about eight months old at the time of its death. It is described as a nursing pup of approximately three feet long. It had a silver-tinged coat which was dark brown above, paler on the sides and nearly white ventrally. The muzzle was whitish and had many coarse whiskers.

Atkinson and Bryan note that the seals are fearless and readily handled, and Blackman (1941) says that if cornered they threaten the intruder by opening their mouths widely and uttering an abrupt barking noise. He also says that they do not migrate, and probably feed on squid and fish. Bailey notes that an animal collected by Henry Palmer in 1891 had its stomach full of half digested fish ; and he also makes an interesting observation that a large male seen in 1949 had a greenish-coloured face, but what the cause of this was he did not say.

SPECIMENS EXAMINED

The following specimens of *Monachus* have been examined. The list includes stuffed animals and skins, and unless otherwise mentioned the specimens are in the British Museum (Natural History).

M. monachus

Skulls only

1. 1853.10.6.4, 1063a. Presented by R. Macandrew.
   Deserta Grande Is. Madeira.
   Type of *Heliophoca atlantica* Gray, 1854.
   Skull and lower jaw of immature animal. Skull with the dorsal part of the cranium, interorbital and nasal regions missing.
   Stuffed animal also in the collection.
2. 1063b. Presented by R. Macandrew.
   Deserta Grande Is. Madeira.
   Skull incomplete—maxillary region bearing teeth, and fragmentary lower jaw only.
3. 1934.8.5.4 Collected by Barrett-Hamilton.
   Mediterranean.
   Complete skull and lower jaw.
4. 1951.4.17.1. From Rothschild Collection, Tring.
   Skull and lower jaw. Zygomatic arches broken.

Skulls and skeletons

1. 1063c. Presented by M. Verreaux.
   Algiers.
   Complete skull and skeleton of an immature animal.
2. 1863.4.1.1, 1421a. Male. Purchased from an Italian.
   N. Mediterranean.
   Complete skull and skeleton of an immature animal.
3. 1892.10.4.1, 1063d. Presented by C. F. R. Blandy.
   Deserta Grande Is. Madeira.
   Complete skull and skeleton of an immature animal.
4. 1892.11.7.1, 1063l. Presented by C. F. R. Blandy.
   Deserta Grande Is. Madeira.
   Complete skull and skeleton of very young animal.
   Skin also in collection.
5. 1894.7.27.1, 1063f. Male. Presented by C. F. R. Blandy.
   Deserta Grande Is. Madeira.
   Complete skull and skeleton of adult animal.
6. 1894.7.27.2, 1063g. Female. Presented by C. F. R. Blandy.
   Deserta Grande Is. Madeira.
   Complete skull and skeleton of adult animal.
   Skin also in collection.
7. 1894.7.27.3, 1063h. Male. Presented by C. F. R. Blandy.
   Deserta Grande Is. Madeira.
   Complete skull and skeleton of immature animal.

The seal was sent alive from Madeira and lived in the Zoological Gardens London from 16th July to 28th October, 1894.
Skin also in collection.

8. 1951.4.17.2. No history.
Incomplete skeleton of an immature animal.
No skull.

Skins

1. 1890.12.30.1. Male. Presented by H. C. Hinton and C. J. Cossart.
Bugio, Deserta Grande Is. Madeira.
Skin of an adult animal.
2. 1892.11.7.1, 1063l.
Skin of very young animal noted above.
3. 1894.7.27.2, 1063g. Female.
Skin of adult animal noted above.
4. 1894.7.27.3, 1063h. Male.
Skin of immature animal noted above.

Stuffed animals

1. 1853.10.6.4, 1063a.
Belonging to type of *H. atlantica* Gray, noted above.
2. 1910.9.27.1. Presented by Zoological Society of London.
Presented to Zoological Society by Godfrey Williams.
Madeira.
3. An immature animal with no history.

M. tropicalis

Skull only

1. 1889.11.5.1, 1064b. Male. Presented by F. D. Godman.
Triangle Is. Gulf of Mexico.
Collected in 1886 by Comision Geografico Exploradoro, Mexico.
Skull and lower jaw of adult animal. Skull complete except for both jugals.
Skin also in collection.

Skull and skeleton

1. 1887.8.5.1. Collected by H. L. Ward.
Triangle Is. Gulf of Mexico.
Complete skull and skeleton of adult, probably female animal.
2. K.7801, 899c. Presented by F. D. Godman.
Triangle Is. Gulf of Mexico.
Complete skull and skeleton of adult animal. In University Zoological Museum, Cambridge.

Skin

1. 1889.11.5.1, 1064b. Male.
   Skin of adult animal noted above.

Stuffed animal

1. 1847.2.2.2. Presented by P. H. Gosse.
   Jamaica.
   Type of *Phoca tropicalis* Gray, 1850.

M. schauinslandi

1. 32795.
   The skull of the type specimen collected on Laysan Id. by Dr. Schauinsland. The skull is in the Zoological Museum in Berlin and has not been examined, but photographs have been made available by Dr. K. Zimmermann, and a very complete set of measurements was published by Matschie (1905).
   A stuffed specimen is believed to be in the Bremen Museum.

OSTEOLOGY

A skull belonging to the genus *Monachus* has the following characters :

1. The skull is broad in proportion to its length.
2. The dorsal surface is convex, sloping backwards and forwards from a point about halfway along the interorbital region.
3. The interorbital region is broad and parallel-sided.
4. The naso-maxillary region is flattened dorsally.
5. The snout is broad, the sides of the maxillae being almost parallel from the upper edge of the infra-orbital foramen to the canines.
6. The molars are large and set more or less obliquely, and there are four upper and four lower incisors.
7. The condyle of the lower jaw is very low, on a level with a line drawn through the points of the molar teeth.

Comparison of the skulls of M. monachus, M. tropicalis *and* M. schauinslandi

1. In view of the small number of skulls examined, few general conclusions can be drawn from the measurements and proportions (Table I), although, as the following summary shows, skulls of *M. monachus* tend to be slightly wider in proportion to their length than skulls of *M. tropicalis* and *M. schauinslandi* (Text figs. 5 and 6, Pl. 6).

	M. monachus. %	*M. tropicalis.* %	*M. schauinslandi.* %
Zygomatic width	59·9–70·3	61·7–62·1	61·5
Snout width at canines	20·9–26·0	20·6–20·9	20·3
Width at external auditory meatus	53·1–58·5	49·8–50·5	50·5
Width at petrous bones	60·3–64·9	56·3–59·2	59·2

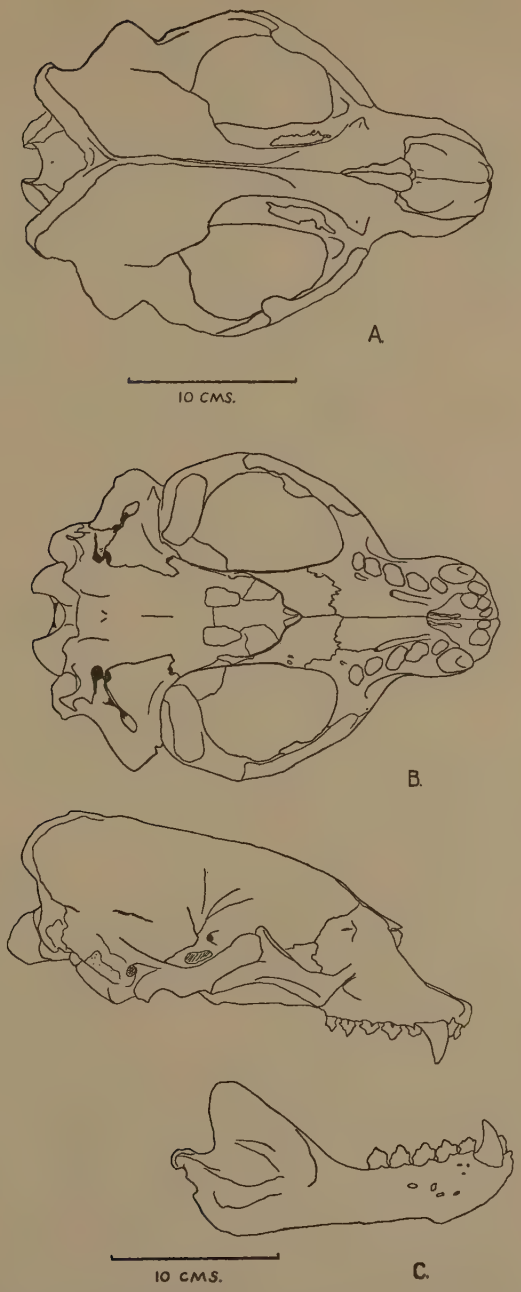

FIG. 5.—*M. monachus* Reg. No. 1894.7.27.1. A. Dorsal view of skull. B. Ventral view. Note supernumerary incisors. C. Lateral view of skull and lower jaw.

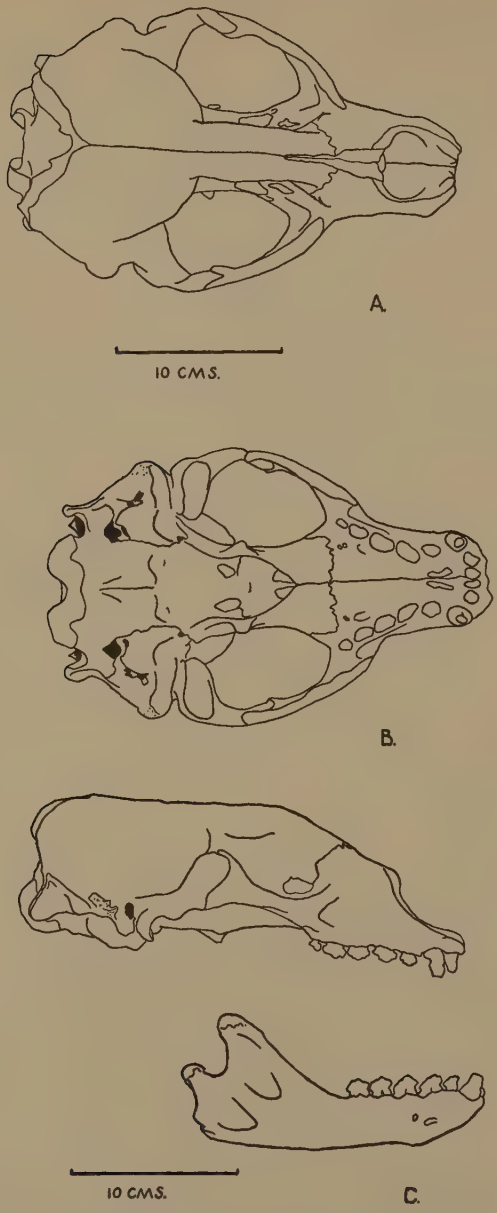

FIG. 6.—*M. tropicalis* Reg. No. 1887.8.5.1. A. Dorsal view of skull. B. Ventral view. C. Lateral view of skull and lower jaw.

2. Each nasal of *M. monachus* ends anteriorly in a V, the point of the V, which may be slightly rounded, being directed anteriorly, so that the ends of both nasal bones together form a W. The nasal septum may project slightly beyond the nasal bones in old specimens. The nasal bones of *M. tropicalis* are much longer and narrower and their anterior ends continue the curve made by the premaxillae. The nasal septum forms a triangular projection. The nasal bones of *M. schauinslandi* are as long as those of *M. tropicalis*, but do not taper to so fine a point posteriorly. The anterior end of each has the form of an inverted V with the point directed posteriorly. The nasal septum appears to project a little beyond the end of the nasal bones (Text-fig. 7).

3. When seen from in front, the lower edge of the infraorbital foramen is wider than the upper edge in *M. monachus*, while the reverse is true in *M. tropicalis*. The foramen is not visible in the photographs of *M. schauinslandi*, although Matschie (1905) says that the lower edge is wider than the upper.

4. There is a well defined tubercle on the maxilla at the anterior margin of the orbit in *M. monachus*. This is very small and indistinct in *M. tropicalis*, and Matschie (1905) says that *M. schauinslandi* also has no clear tubercle in this position.

5. In *M. monachus* the zygomatic branch of the squamosal is not expanded at its anterior end and lies at an angle of approximately 45° with the base of the skull. The orbital process of the jugal is wide and upwardly directed while the lower branch is narrower and continues back along the squamosal for some distance.

In *M. tropicalis* the zygomatic branch of the squamosal is expanded at its anterior end and is much more nearly vertical. The orbital process of the jugal is very narrow and curves backwards over the top of the zygomatic branch, while its lower branch is short and triangular.

In *M. schauinslandi* the zygomatic branch of the squamosal is similar to that of *M. monachus*; it is not expanded and lies at an approximate angle of 45°. The orbital process of the jugal is not quite so wide as that of *M. monachus*, but is otherwise similar, and the lower branch is long and backwardly directed (Text-fig. 7).

6. The posterior end of the palate of *M. monachus* is U-shaped with a small median V-shaped incision. In *M. tropicalis* it is V-shaped, and in *M. schauinslandi* it forms a slightly wider V. (Text-fig. 7).

7. The pterygoid bones of *M. monachus* are low and ill-defined, and are not visible when the skull is viewed dorsally. In *M. tropicalis* they curve widely outwards and are visible dorsally. In *M. schauinslandi* they curve out as in *M. tropicalis*, but are not visible dorsally.

8. The coronoid process of the lower jaw of *M. monachus* is wide and concave internally. That of *M. tropicalis* is narrow and only very slightly concave. The coronoid of *M. schauinslandi* is narrow and like that of *M. tropicalis*.

9. From the above characters it will be seen that the skull of *M. schauinslandi* is more like that of *M. tropicalis* than *M. monachus*.

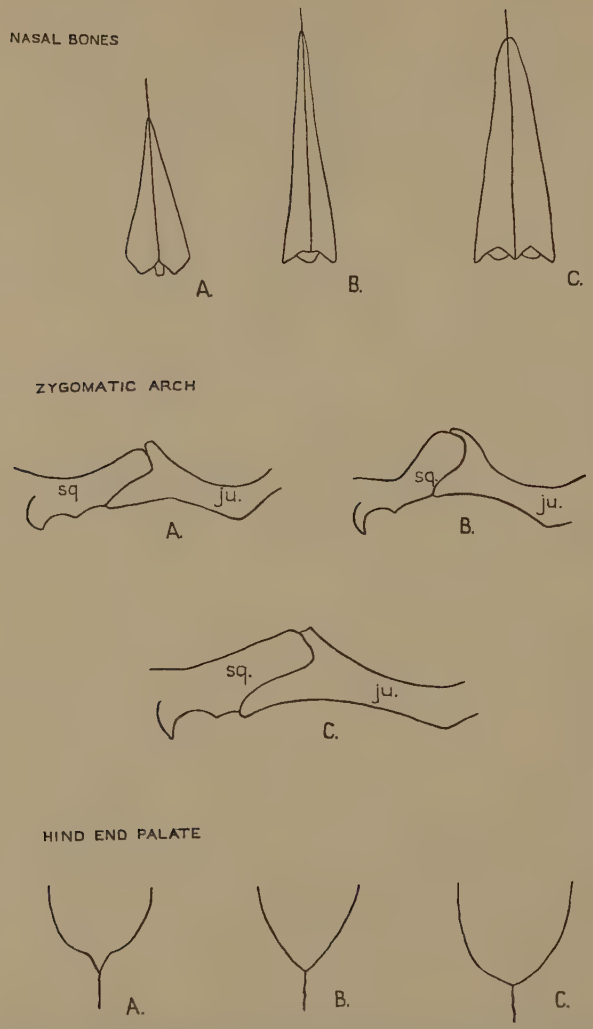

FIG. 7.—Nasal bones, zygomatic arch and hind end of palate of A. *M. monachus*, B. *M. tropicalis*, C. *M. schauinslandi*. *sq.*, squamosal; *ju.*, jugal.

TABLE I.—*Cranial Measurements of* Monachus *Skulls.*

M. monachus.

	1951.4.17.1.		1894.7.27.1.		1863.4.1.1.		1894.7.27.2.		1934.8.5.4.	
	mm.	%	mm.	%	mm.	%	mm.	%	mm.	%
Condylobasal length	295	100	281	100	273	100	268	100	262	100
Condylo-basilar length	282	95·5	270	96·1	262	95·9	258	96.2	253	96·5
Basal length	279	94·5	263	93·5	251	91·9	251	93·6	241	91·9
Basilar length	266	90·1	252	89·6	241	88·2	241	89·9	232	88·5
Snout width at canines	71	24·1	68	24·1	71	26·0	57	21·2	55	20·9
Width of skull at front end of last upper molars	80	27·1	76	27·0	85	31·1	60	22·3	64	24·4
Zygomatic width	205 est.	69·4	193	68·6	185	70·3	176	65·6	159	60·6
Width at upper edge auditory meatus	166	56·2	156	55·5	150	54·9	145	54·1	139	53·1
Width at petrous bones	178	60·3	177	62·9	165	60·4	167	62·3	160	61·1
Palatal length	127	43·1	117	41·6	113	41·3	110	41·0	106	40·4
Palatilar length	113	38·3	107	38·1	103	37·7	100	37·3	97	37·0
Width of occipital condyles	65	22·0	67	23·8	64	23·4	65	24·2	65	24·8
Length of nasal suture	57	19·3	46	16·3	52	19·0	53	19·7	49	18·7
Length of upper molar row	64	21·6	60	21·3	64	23·4	57	21·2	56	21·3

M. monachus.

	1892.10.4.1.		1894.7.27.3.		1853.10.6.4.		1892.11.7.1.		1063c.	
	mm.	%	mm.	%	mm.	%	mm.	%	mm.	%
Condylobasal length	260	100	224	100	217	100	171	100	217	100
Condylo-basilar length	249	95·7	216	96·4	212	97·7	164	95·9	208	95·9
Basal length	241	92·6	207	92·4	197	90·8	156	91·2	197	90·8
Basilar length	230	88·4	198	88·4	191	88·0	147	85·9	188	86·6
Snout width at canines	61	23·4	52	23·2	51	23·5	44	25·7	50	23·0
Width of skull at front end of last upper molars	66	25·3	63	28·1	63	29·0	56	32·7	67	30·9
Zygomatic width	164	63·1	139	62·1	130	59·9	108	63·2	137	63·1
Width at upper edge auditory meatus	144	55·3	126	56·2	123	56·7	100	58·5	122	56·2
Width at petrous bones	163	62·6	138	61·6	136	62·7	111	64·9	136	62·7
Palatal length	102	39·2	90	40·1	91	41·9	73	42·7	92	42·4
Palatilar length	92	25·3	82	36·6	85	39·2	65	38·0	84	38·7
Width of occipital condyles	69	26·5	63	28·1	62	28·6	54	31·6	57	26·3
Length of nasal suture	48	18·4	53	23·6	—	—	38	22·2	39	17·9
Length of upper molar row	56	21·5	51	22·7	52	23·9	*ca*46	26·9	55	25·3

TABLE I—*cont.*

	M. tropicalis.						*M. schauinslandi.*	
	889c. (Cambridge)		1887.8.5.1.		1889.11.5.1.		32795.	
	mm.	%	mm.	%	mm.	%	mm.	%
Condylobasal length	272	100	269	100	267	100	265	100
Condylo-basilar length	263	96·7	262	97·3	258	96·6	255	96·2
Basal length	260	95·6	254	94·4	250	93·6	252	95·1
Basilar length	250	91·9	247	91·8	241	90·2	241	90·1
Snout width at canines	56	20·6	56	20·8	56	20·9	54	20·3
Width of skull at front end of last upper molars	77	28·3	74	27·5	80	29·9	70	26·4
Zygomatic width	168	61·8	167	62·1	165	61·7	163	61·5
Width at upper edge auditory meatus	136	50·0	136	50·5	133	49·8	134	50·5
Width at petrous bones	153	56·3	154	57·2	151	56·5	157	59·2
Palatal length	111	40·8	116	43·1	112	41·9	122	46·0
Palatilar length	102	37·5	110	40·8	104	38·9	112	42·2
Width of occipital condyles	67	24·6	69	25·6	63	23·5	66	24·9
Length of nasal suture	67	24·6	65	24·1	61	22·8	61	23·0
Length of upper molar row	66	24·3	65	24·1	66	24·7	—	—

M. monachus

Teeth

Dental formula : $i\frac{2}{2}, c\frac{1}{1}, m\frac{5}{5}$

Upper.—The incisors are large and pointed, the point directed posteriorly. The outer incisors are larger than the inner and there is a well developed cingulum on the inner surface of all four teeth.

The canines are of moderate size with a slight ridge down the posterior surface.

The molars are large, the 3rd being the largest and the others decreasing in size in the order 3, 2, 4, 1, 5, except in the largest skull (1951.4.17.1) where the 5th is slightly greater than the first, and the others decrease in size from before backwards. Although the molars are set obliquely they do not overlap one another. The first molar makes an angle of 20° with the median palatal suture, the 2nd molar 40°, the 3rd molar 60°, the 4th molar 70° and the 5th molar 110°, so that its palatal surface is facing posteriorly. The external edge of the palate forms an angle of 20° with the median palatal suture. These measurements are from 1892.10.4.1, and are compared with a *Phoca vitulina* 1919.7.7.3260, where the teeth are set in line at an angle of 20°. There is a slight obliquity in the teeth of some of the other *P. vitulina* skulls, but this is not nearly so pronounced as in *M. monachus*. All the molars are double rooted except the first. The molars have a large central cusp and single

smaller anterior and posterior cusps. The small cusps on the 5th molar are less distinct and the posterior one may be lacking. There is a well developed cingulum on the inner surface.

Variation.—In the nine specimens with fully erupted teeth, variations in the number of upper incisors occur in five of them.

1. 1853.10.6.4, 1063a.
   There is a small extra tooth just posterior to the first left incisor.
2. 1063b.
   Although the tooth is missing in the specimen, the alveolus shows evidence of an extra tooth posterior to the first right incisor.
3. 1894.7.27.1, 1063f.
   On the right side there is a small incisor median to the first and in the same line with it. The first incisor is the same size as that on the left side, though farther from the mid line. The second incisor on the right side is separated from the first by a gap, and leans away from it, towards the canine. It is considerably smaller than the left second incisor. Posteriorly and internally to the first and second right incisors is part of the root of a tooth larger than the left second incisor and smaller than the canine. The crown has been broken off since the animal died.
4. 1934.8.5.4.
   On the left side a small incisor is set directly behind the first.
5. 1951.4.17.1.
   On the left side a small incisor is situated just posteriorly to the first.

Disease.—Only one specimen shows any sign of disease in the teeth. 1863.4.1.1, 1421a—the second right incisor has lost most of the crown, the tooth is hollow, and there is some lumpy growth on its anterior surface. The parts of the premaxilla round the tooth have fallen away.

Lower.—The first incisors are considerably smaller than the second, they are set internally and posteriorly to them and are in a more or less recumbent position. They are similar to the upper incisors in shape ; the canines are also similar.

The third molar is the largest, the others decreasing in size in the order 3, 2, 4, 5, 1, so that the 1st molar is the smallest. The molars are set obliquely and do not overlap one another. The first molar is set directly behind the canine, so close that the two alveoli are confluent, but the molar is not on the inner surface of the canine as in the upper jaw. The angle the teeth make with the symphysial line is not so varied as in the upper jaw. The 1st molar makes an angle of 30°, the 2nd 40°, the 3rd 40°, the 4th 60°, and the 5th 20°. As the ramus itself is at an angle of 20° the 5th molar is in line with the jaw. These measurements are from 1863.4.1.1, 1421a. All the molars are double rooted except the first. The shape of the lower molars is similar to that of the upper, except that the posterior cusp on the 5th molar is generally present.

There are no variations in number, and no disease is present. The surface of all the teeth, both upper and lower, is slightly rugose.

M. tropicalis

Dental formula : $i\frac{2}{2}, c\frac{1}{1}, m\frac{5}{5}$

Upper.—The incisors are set in a straight line across the front of the premaxillae. They are similar in general shape to those of *M. monachus*, although there is more of a " waist " at the junction of root and crown. The canines are similar to those of *M. monachus*.

The molars are large, the 3rd is largest and the others decrease in size in the order 3, 2, 4, 1, 5. They are hardly oblique, the 2nd molar being the most so. The molars are double rooted except the first, and the last also appears to have only one root in the two British Museum specimens. The molars have a low central cusp, and one anterior and two posterior smaller cusps. The 5th molar has only a single posterior cusp. All the teeth have a well developed cingulum and the crown is slightly rugose.
Variation and disease.—In the three skulls examined there is no variation or disease in upper or lower teeth.
Lower.—The first lower incisors are smaller than the second, are set internally and posteriorly to them and are in a recumbent position. In shape they are similar to the upper incisors. The lower canines are similar to the upper ones.

The 3rd molar is the largest and the others decrease in size in the order 3, 4, 2, 5, 1, although molars 3, 4 and 2 are very much of the same size. The teeth are set in the line of the jaw, not obliquely. All the molars are double rooted except the first. The lower molars are similar in shape to the upper except that the cusps on the 1st are rather indistinct, and there is only one small posterior cusp on the 5th.

The teeth of *M. tropicalis* examined seem to be more worn than the teeth of *M. monachus*.

M. schauinslandi

Dental formula : $i\frac{2}{2}, c\frac{1}{1}, m\frac{5}{5}$

Upper.—The incisors are set in a straight line across the front of the premaxillae, and as far as can be seen from the photographs, the setting and shape of the teeth are similar to those of *M. tropicalis*. The molars are not set obliquely and seem to have a main low cusp, a single small anterior cusp and two small posterior cusps.
Lower.—The lower teeth appear to be similar to those of *M. tropicalis*.

Summary of the differences between the teeth

1. The incisors have a very pronounced " waist " at the junction of root and crown in *M. tropicalis* and *M. schauinslandi*.
2. The molars are set very obliquely in *M. monachus*.
3. The molars of *M. monachus* have a large central cusp and single smaller anterior and posterior cusps. Those of *M. tropicalis* and *M. schauinslandi* have a low central cusp, a single small anterior cusp and two small posterior cusps.

4. The incisors are set straight across the premaxillae in *M. tropicalis* and *M. schauinslandi*, but on a slight curve in *M. monachus*.

Teeth of a very young M. monachus

There is no exact information about the skull 1892.11.7.1, 10631, but from its size and the condition of its teeth it is probably new-born. X-rays of the teeth were taken (Nos. 764 and 765) (Text-fig. 8).

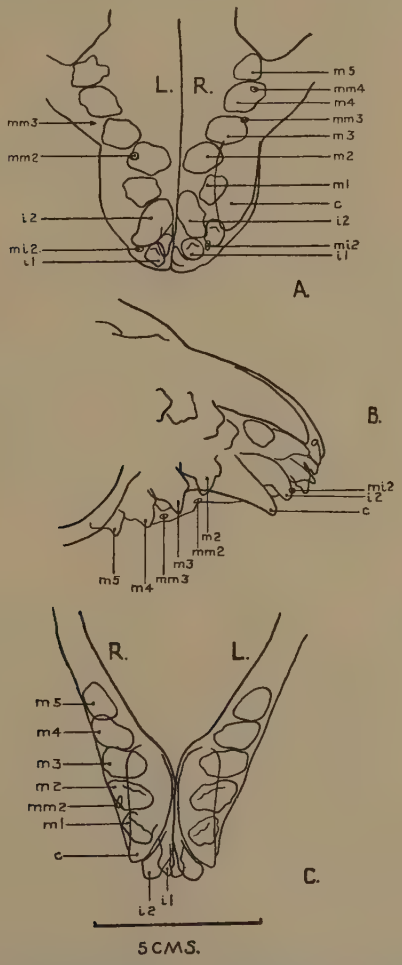

FIG. 8.—Tracings from X-ray photographs of the teeth of a young *M. monachus*, Reg. No. 1892.11.7.1. A. Ventral view. B. Oblique view. C. Lower jaw.

Milk teeth

These are seen more clearly in the skull itself than in the X-ray. Six milk teeth are visible in the upper jaw, three on each side. They are very small, the largest being 2 mm. long; they have no roots and are present in the dried gum over the unerupted permanent teeth. The milk molars are placed behind their permanent successors. In the upper jaw milk molars 3 and 4 are present on the right side, and 2 and 3 on the left side. The two outer milk incisors are present. In the lower jaw the only milk tooth present is mm 2 on the right side.

There is no milk predecessor for the first molar in either upper or lower jaws.

Milk dentition: $i\frac{2}{2}$, $c\frac{1}{1}$, $m\frac{3}{3}$

Permanent teeth

The tips of all the permanent teeth are through the layer of dried skin on the skull, though probably apart from the upper canines, none of them would have pierced the gum in the living animal.

The permanent molars are large, but are normal in shape and position. This specimen shows an interesting variation in the number of incisors. The upper jaw has seven incisors, three of which are supernumerary. On the left side the outer incisor is in its normal position, the inner incisor is pushed a little further away from the mid line than is normal, and on its median surface, slightly posteriorly is a small extra tooth. On the right side the outer incisor is displaced posteriorly by an extra tooth which is between it and the canine, and between the inner incisor and the mid line is another extra tooth of the same size as the small extra one on the left side. The larger extra tooth on the right has the same size and appearance as the inner incisor.

The lower permanent teeth are normal.

Supernumerary bones in the skull.

Three of the youngest skulls of *M. monachus* (1892.11.7.1, 1063c and 1894.7.27.3) have supernumerary bones in the cranium. The youngest specimen (1892.11.7.1) has two bones symmetrically placed in the back of the skull, each bone bounded by exoccipital, parietal and supraoccipital. These bones are frequently found in the young of other seals and have been known as the tabulare, on the assumption that they were homologous with the tabulare of the reptilian skull. Doutt (1942) mentions their presence as well as that of two small adjacent bones, in skulls of *Phoca vitulina* and *P. hispida* and after quoting various authors who have considered the relationships of these bones with those in the reptilian skull, he thinks "that it is better, for the present at least, to consider these extra bones in the occipital region of the seal as being of the nature of fontanelle bones rather than to try to homologize them with elements in the reptilian skull". He says that these "extra-occipital" bones cannot be considered as Wormian bones for they are too symmetrical and too regularly situated.

Undoubted Wormian bones are also found in this skull and in the two other young ones mentioned. In 1892.11.7.1 they take the form of three small bones, two posteriorly and one anteriorly, at the junction of the two parietal bones with the frontal bones. In 1063c there is a single triangular bone in the same position. Also in the same position in 1894.7.27.3 there are two narrow bones one behind the other (Text-fig. 9).

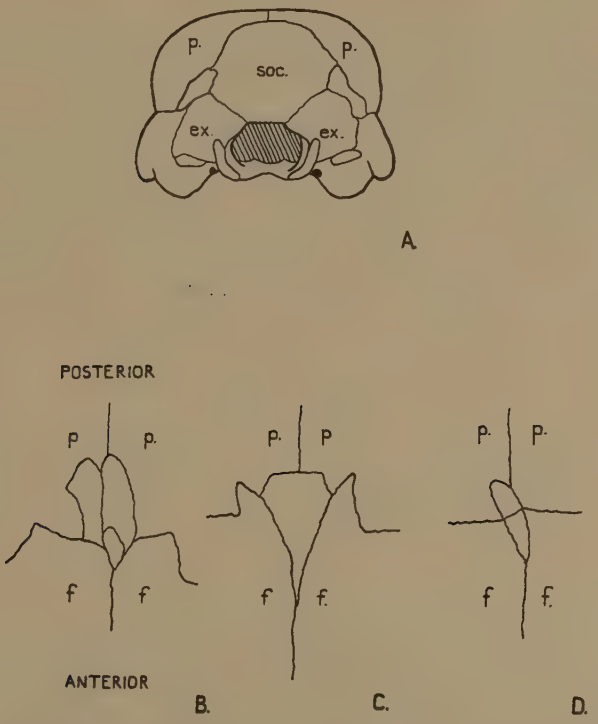

FIG. 9.—A. "Extra-occipital" bones in *M. monachus* Reg. No. 1892.11.7.1. B. Wormian bones in *M. monachus* Reg. No. 1892.11.7.1; C. Wormian bones in *M. monachus* Reg. No. 1063c; D. Wormian bones in *M. monachus* Reg. No. 1894.7.27.3. *p.*, Parietal; *f.*, frontal; *ex.*, exoccipital; *soc.*, supraoccipital.

Scapula (Text-fig. 10)

The scapula of *Monachus* is triangular in shape, the extreme antero-posterior length being greater than the height. In this character it differs from the scapulae of other Phocids where the anterior edge is much longer and, especially in the southern Phocids, much more square in shape. The junction of the posterior and dorsal edges is not hook-shaped. The spine is low and poorly developed like those

of *Mirounga* and the southern Phocids, and very unlike the plate like spines of *P. vitulina* and *H. grypus*. The acromion process is well developed and resembles that of the southern Phocids, and the glenoid cavity is narrow and kidney-shaped. The outer surface of the scapula is convex anteriorly to the spine and concave posteriorly to it. Scapulae of *P. vitulina* and *H. grypus* are convex posteriorly and concave anteriorly.

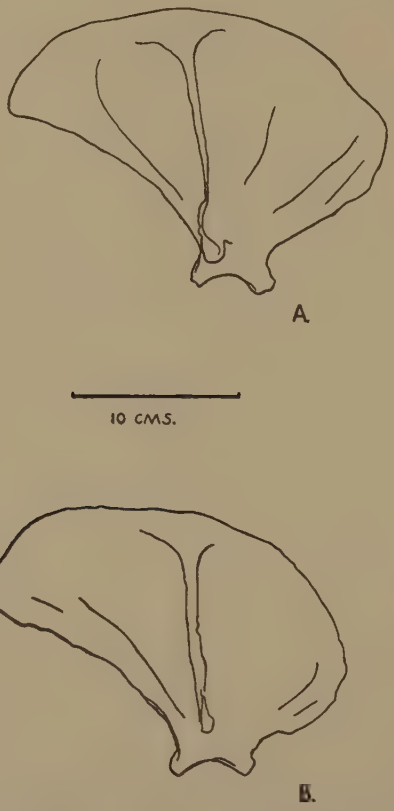

FIG. 10.—Scapulae of A. *M. monachus* Reg. No. 1894.7.27.1.
B. *M. tropicalis* 1887.8.5.1.

In young *M. monachus* and in *M. tropicalis* the anterior edge of the scapula sweeps round in a continuous curve from the neck, forwards and then back along the dorsal edge. In adult *M. monachus* the anterior edge is more squared off. The scapula of *M. tropicalis* is more elongated antero-posteriorly than that of *M. monachus*.

The separate origin of the coracoid is visible in three of the youngest specimens of *M. monachus*. In the youngest scapula (1892.11.7.1) it does not appear to have

begun to ossify. Scapulae 1894.7.27.3, and 1063c have the cartilage still present over the glenoid cavity and the coracoid is visible as a distinct bone embedded in it. Scapula 1892.10.4.1 has no cartilage, the coracoid has fused to the anterior edge of the glenoid cavity, but is still recognizable as a separate entity.

Humerus

The humerus is short and robust. In common with all the southern Phocids there is no supracondylar foramen. This foramen is present in *Phoca*, *H. grypus*, *E. barbatus* and *C. cristatus*. The deltoid ridge is strongly developed and extends nearly the whole length of the shaft. The deltoid rugosity on the external surface of the ridge is more prominent in *M. monachus* than in *M. tropicalis*, but does not overhang to so great an extent as in *Phoca*, *Halichoerus* and *Erignathus*. The bicipital groove is broad and shallow. In *Monachus* and the southern Phocids there is only a very poorly marked supinator ridge, while this is well developed in the northern Phocids. For bones of approximately the same length, the humerus of *M. tropicalis* (Pl. 7,A) is slightly more slender than that of *M. monachus*. The distal articular surface is narrower and appears to be slightly more oblique than in *M. monachus*. In *M. tropicalis*, but not in *M. monachus* there is a very slight anconeal fossa.

Radius and Ulna.

The radius is laterally flattened and bowed forward, so that its hinder edge is concave. The ulna is compressed laterally, with an expanded olecranon process and a concave hinder margin. The ulna of *M. monachus* is slighty more stoutly built than that of *M. tropicalis*, but presents no special modifications.

Manus (Pl. 7,A)

The carpus consists of seven bones: scapholunar, trapezium, trapezioid, os magnus, unciform, cuneiform and pisiform. The length of the digits, and of the metacarpals decreases in size from the first to the fifth. The first digit is strongly built, the fifth slightly less so, and the second, third and fourth of equal thickness. The terminal phalanges are grooved for the insertion of claws. An X-ray taken of the manus of an immature *M. monachus* (1894.7.27.3) shows the presence of distal epiphyses on all five metacarpals, but a proximal epiphysis on only the first. All the phalanges except the terminal ones have epiphyses on both ends, and a proximal epiphysis is visible only on the first terminal phalange, it not yet having ossified on the remaining phalanges.

Pelvis and sacrum

The innominate bones are of the typical Phocid pattern with short recurved ilia and long ischia and pubes. The symphysial area is very small and appears to be mainly cartilaginous. The innominate bones of *M. monachus* have thick flattened ilia which are not excavated on their exterior surfaces as in *Phoca* and *Halichoerus*.

When compared with the innominate bones of other Phocids it is seen that the ilia of *M. monachus* are everted and also are rotated upwards relative to the plane of the pubes and ischia, so that the external surfaces of the ilia face slightly posteriorly and dorsally. In *Phoca* and *Halichoerus* and also in the southern Phocids the ilia are everted in approximately the same plane as the pubes and ischia. The ischium of *M. monachus* is strongly built, approximately circular in cross section until about the level of the ischiatic spine, when it continues as a flat bar. The pubis is also thicker at its origin and flattens out posteriorly to meet the ischium. The ischium forms the upper and practically the whole of the posterior border of the obturator foramen before it meets the pubis.

A comparision of the innominate bones of Phocids shows that in the northern genera *Phoca, Halichoerus* and *Erignathus* the obturator foramen is long and narrow and the width of the innominate at the level of the ischiatic spine less; in the southern genera *Ommatophoca, Hydrurga, Leptonychotes, Lobodon* and *Mirounga* the obturator foramen is broad and the width of the innominate correspondingly greater. The proportions of the obturator foramen given in the table below indicate a closer relationship of *Monachus* with the Southern than the Northern Phocids (Pl. 8).

Measurements of the Obturator Foramen

	Extreme antero-posterior length. (mm.)	Greatest width. (mm.)	Proportion of width to length.
P. vitulina	96	31	32·3
H. grypus	100	26	26·0
E. barbatus	112	37	33·0
L. weddelli	103	43	41·7
H. leptonyx	107	57	53·3
L. carcinophagus	97	53	54·6
O. rossi	88	45	51·1
M. monachus			
1063g.	94	51	54·3
1063f.	98	55	56·1
1421a.	82	50	60·9
M. tropicalis			
1887.8.5.1	112	50	44·6
899c.	114	52	45·6

In *M. monachus* the pectineal tubercle and the ischiatic spine are well developed, the acetabulum is deep and circular with a well marked cotyloid notch. The innominate bones articulate with two sacral vertebrae, but in the three adult *M. monachus*, two have four vertebrae fused to form the sacrum, and one—the youngest—has three. The wings of the sacrum are broad and strong, and articulate on their posterior surfaces with the ilia.

In most respects the pelvis of *M. tropicalis* is similar to that of *M. monachus*, but the size of the ischium and pubis differs considerably. The pubis is extremely strongly built, is circular in cross section, tapers slightly towards its posterior end and does not flatten out except at the symphysial area. The ischium is much more slender than the pubis, and posterior to the ischiatic spine it is only a very narrow bar, triangular in cross section.

Femur

The femur is short and flattened antero-posteriorly. The greater trochanter is large and thickened and is separated from the head by a groove which is deeper and more distinct in *M. monachus* than in *M. tropicalis*. In common with all Phocids except *Phoca* and *Halichoerus* there is no trace of a digital fossa. The distal end of the femur is very broad because of the great development of the epicondyles. In general shape, and in particular in the great width in proportion to its length, the femur of *Monachus* is more like that of the Southern than the Northern Phocids.

Patella

The patella of *M. monachus* is a small flat bone articulating with the femur. The measurements of specimen 1033f are: Greatest antero-posterior length 26 mm. Greatest height anteriorly 15 mm. The patella of *M. tropicalis*, while of the same general length, is, particularly in the Cambridge specimen, higher and more pyramidal. The measurements of the British Museum and Cambridge specimens respectively are: Greatest antero-posterior length 30 mm., 24 mm. Greatest height anteriorly 20 mm., 28 mm.

Tibia and Fibula

The tibia and fibula are of the usual pinniped form, the two bones being fused at the proximal end, but separate from each other at the distal end. In only one of the *M. monachus* in the collection (1063g) is one of the fibulae fused to the tibia, so this fusion must be one of the last to occur. The posterior tibial fossa is less concave than in any of the other Phocids examined, but the tibial spine and the anterior tibial fossa are quite well marked. Both the tibia and the fibula articulate at their lower ends with the astragalus.

Pes (Pl. 7,B)

The tarsus consists of seven bones: astragalus, calcaneum, navicular, cuboid and external, middle and internal cuneiform bones. The length of the digits and of the metacarpals decrease in size in the order 1, 5, 2, 4, 3, the middle digit being the shortest. The outer digits are the most strongly built. The terminal phalanges are grooved for the insertion of small claws. An X-ray taken of the pes of a young *M. monachus* (1894.7.27.3) shows the presence of distal epiphyses on all the metatarsals, and a proximal one on the first only. Epiphyses are visible on both

ends of all the phalanges except the terminal ones. Epiphyses have not yet ossified on the proximal ends of any of the terminal phalanges except the first.

Vertebral Column

The vertebral formula is as follows :

	Cervical.	Thoracic.	Lumbar.	Sacral.	Caudal.
M. monachus					
1892.11.7.1, 1063l.	7	15	5	2	3+
1894.7.23.3, 1063h.	7	15	5	3	11
1894.7.27.2, 1063g.	7	15	5	4	11
1894.7.27.1, 1063f	7	15	5	4	11
1892.10.4.1, 1063d	7	15	5	3	11
1863.4.1.1, 1421a	7	15	5	3	11
1063c	7	15	5	2	10
M. tropicalis					
1887.8.5.1	7	15	5	3	12
899c	7	15	5	3	12

Cervical vertebrae

M. monachus.—The centra are approximately circular in cross section and the ventral surfaces have a median keel in all except the atlas. The neural arches are narrow antero-posteriorly, the widest (the 7th) being 20 mm., and the neural spines increase from a hardly perceptible point on the third vertebra to a spine 38 mm. high on the seventh. The transverse processes are perforated by the vertebrarterial canal in all except the seventh. The transverse processes of cervical vertebrae 3–6 inclusive are, in all the Phocidae examined, divided into two branches, a dorsal transverse element which is more or less at right angles to the median plane, and directed slightly posteriorly, and a ventral costal element which is directed more or less vertically downwards and is expanded antero-posteriorly into a plate which is greatest in the sixth vertebra. In *M. monachus* the transverse processes leave the centrum at an angle of approximately 45° and are not divided into two branches (Text-fig. 11).

The cervical vertebrae of *M. tropicalis*, while conforming to the same general pattern as those of *M. monachus*, are different in several minor respects. They give the general impression of being more finely built than those of *M. monachus*. The transverse process of the atlas is not so massive and the vertebrarterial canal is much larger, the neural spine of the axis is not so high and does not project so far backwards. The transverse process of the axis is thin and pointed, those of vertebrae 3–6 are divided into two branches, the costal element not being so expanded as in *Phoca* and directed not vertically, but laterally at an angle of approximately 45°, and inclining posteriorly. The general shape of the cervical vertebrae and in particular that of the transverse process is more like *Leptonychotes* than *Phoca*.

It is interesting to note that both in the British Museum and the Cambridge specimens of *M. tropicalis* the neural arches of the third and fourth vertebrae do

not meet dorsally. In the British Museum specimen the two sides of the neural arch of the fifth vertebra are fused, but the lateral tips of the spine are curved outwards, to give a bifurcated tip to the spine. The lateral tips of the sixth spine are less curved. In the Cambridge specimen the two sides of the fifth neural arch

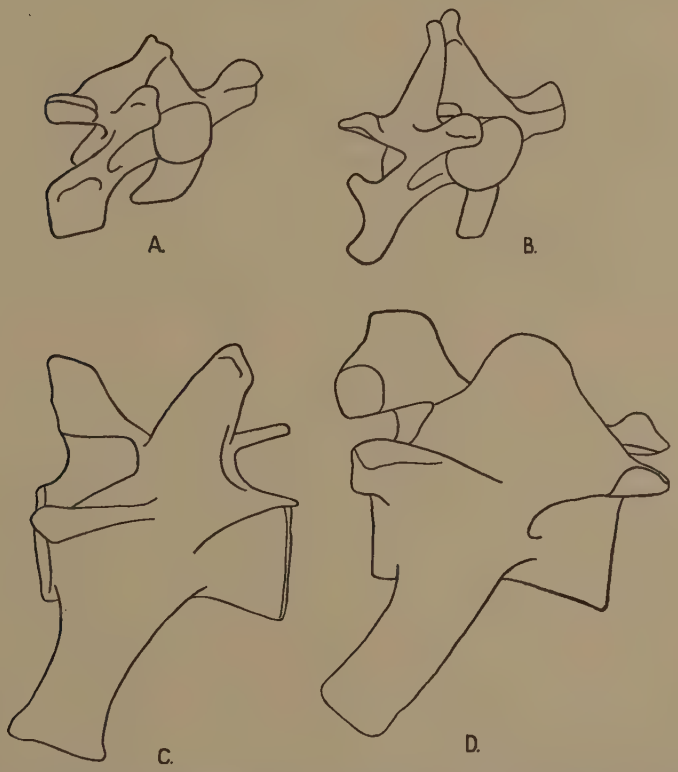

FIG. 11.—A. 5th cervical vertebra of *M. monachus* Reg. No. 1894.7.27.2. B. 5th cervical vertebra of *M. tropicalis* Reg. No. 1887.8.5.1. C. 2nd lumbar vertebra of *M. monachus* Reg. No. 1894.7.27.2. D. 2nd lumbar vertebra of *M. tropicalis* Reg. No. 1887.8.5.1.

meet, but are not fused, and the tips curve outwards. The spine of the sixth is fused with curved tips, and the spine of the seventh in both animals is normal. A similar non-fusion of the neural arch occurs in *M. monachus* 1063c, where the two sides of the third neural arch fail to meet. The remaining arches are normal and do not have the bifurcated appearance of those of *M. tropicalis*. Ward (1887b)

says, describing *M. tropicalis*, " At no time does this seal raise its head as much above the line of its back as does the harbor seal: the flexibility of its cervical vertebrae appearing to be quite restricted ". It is difficult to know whether this is a character that applies to *M. tropicalis* in general, or only to the animals that Ward saw; or whether it has any connection with the non-fusion of the neural spines, as the two animals in which this character is present were both collected by Ward from a single group of animals.

Thoracic vertebrae

The thoracic vertebrae of *M. monachus* articulate with fifteen pairs of ribs. Ribs 1 and 2, and 11, 12, 13, 14 and 15 articulate only with the corresponding thoracic vertebra, but the capitular articulation of ribs 3–10 inclusive overlaps on to the centrum of the vertebra in front. Ribs 1–13 inclusive articulate by both capitular and tubercular heads, the two articulations getting closer together until ribs 14 and 15 articulate by means of a single head only. The transverse processes are prominent, but diminish in size from the first to the tenth vertebra and are hardly visible from the eleventh to the fifteenth. The neural spines are high and pointed in the first five vertebrae, but get progressively smaller and more backwardly inclined.

Between thoracic vertebrae 9 and 10 in specimen 1863.4.1.1, the anterior common ligament has ossified in the form of a bony plate, which is fused to the centrum of the tenth vertebra and extends anteriorly for 4cm. beyond it. Evidences of a similar abnormality, though to a much lesser extent, are present on the ventral surfaces of the centra of vertebrae 11, 12 and 13.

The thoracic vertebrae of *M. tropicalis* are practically the same as those of *M. monachus* except that the neural arches are wider and the neural spines are shorter and less pointed.

Measurements of thoracic vertebrae

	M. monachus. 1063g. mm.	*M. tropicalis.* 1887.8.5.1. mm.
Length medially of neural arch of 10th vertebra	48	46
Least width " " "	25	34
Height* of neural spine of 1st vertebra	58	51
" " " 5th "	65	52
" " " 10th "	54	46
Length of centrum of 1st "	41	40
" " " " 10th "	52	51

* Height not taken vertically, but medially along spine.

Lumbar vertebrae

The lumbar vertebrae of *M. monachus* have large heavy centra that are slightly concave ventrally. The transverse processes are prominent and project anteriorly and ventrally. The cephalic articular processes are large and are directed obliquely

anteriorly, but the caudal articular processes are extremely small and thin, and may not even reach the vertebra behind. The neural spines are stoutly built and are directed slightly posteriorly.

The right transverse process of the first lumbar vertebra of *M. monachus* 1063f is normal, but the left is stout, truncated, and its distal end forms an articulation for a small triangular " pleurapophysial " ossicle 34 mm. in length.

A condition of chronic osteo-arthritis is present on the posterior half of the centrum of the fifth lumbar vertebra of *M. monachus* 1063g, and this condition has spread to the centrum of the first sacral vertebra.

The lumbar vertebrae of *M. tropicalis* are in general like those of *M. monachus*, though the articulations are normal, the caudal articular process overlapping to a considerable extent the cephalic articular surface of the next posterior vertebra. The neural spines are laterally flattened, low, rounded, and either vertical or inclined slightly anteriorly (Text-fig. 11).

Caudal vertebrae

Except for the first two or three, the caudal vertebrae are without a neural arch, and both the number and size of the processes, and also the size of the centrum, diminish in size from before backwards.

Ribs

The articulations of the ribs with the thoracic vertebrae have already been discussed. In *M. monachus* (1063f) the ribs increase in length from the 1st (77 mm.) to the 11th (263 mm.) and then decrease to the 15th (209 mm.). In *M. tropicalis* (1887.8.5.1) similar measurements are 1st (71 mm.), 11th (255 mm.) and 15th (189 mm.).

The adult specimens of *M. monachus* in the collection lack the cartilaginous portions of the ribs. An immature *M. monachus* (1063c) has cartilaginous ribs attached directly to the sternum from bony ribs 1–9 inclusive. Cartilaginous ribs 10–15 inclusive turn forward and lie against the cartilaginous portion of the rib in front.

Cartilaginous ribs 1–10 inclusive of *M. tropicalis* (1887.8.5.1) are attached directly to the sternum, 11 and 12 are long and lie against the cartilaginous portion of the ribs in front, but the cartilaginous portions of ribs 13–15 are very short, between 35 and 70 mm. long, and are unattached ventrally.

The first cartilaginous rib articulates with the manubrium of the sternum, the remaining nine with the cartilages between the sternebrae, ribs both 8 and 9 articulating with the last cartilage.

Sternum

The sternum of both *M. monachus* and *M. tropicalis* consists of nine sternebrae, although there are only eight present in *M. monachus* 1063c. The sternebrae are dorso-ventrally flattened and more or less quadrate in shape, the first and last being

more elongated. The xiphisternum is prolonged posteriorly into two cartilaginous extensions, the ends of which are expanded and joined together posteriorly.

GROWTH

In view of the small number of specimens available no attempt at age determination has been made but it has been possible to do a certain amount on the growth of the skull and skeleton.

Following Doutt's (1942) method for estimating the "suture age" of the skull the following table was drawn up. (Table II). As suture closure is a gradual process the degree of closure has been given a value: 1 for open, 2 for less than half closed, 3 for more than half closed, and 4 for completely closed, and the total for each skull is known as the "suture age" for that specimen.

TABLE II.—*Suture Ages of the Skulls*

Registered No.	Occipito-parietal.	Squamoso-parietal.	Sagittal.	Coronal.	Basioccipito-basisphenoid.	Basisphenoid-presphenoid.	Interfrontal.	Internaxillary.	Fronto-maxillary.	Jugal-maxilla.	Squamosal-jugal.	Palato-maxillary.	Suture age.
M. monachus:													
1892.11.7.1	1	1	1	1	1	1	1	1	1	1	1	1	12
1063c	1	1	1	1	1	1	1	1	1	1	1	1	12
1894.7.27.3 ♂	2	1	1	1	1	1	1	1	1	1	1	1	13
1892.10.4.1	4	1	1	2	1	1	1	1	1	1	1	1	16
1934.8.5.4	4	1	2	2	2	1	1	1	1	1	1	1	18
1894.7.27.2 ♀	4	4	4	4	4	4	1	1	1	1	1	1	30
1863.4.1.1 ♂	4	4	4	3	4	1	1	1	1	1	1	1	26
1894.7.27.1 ♂	4	4	4	4	4	2	1	1	1	1	1	1	28
1951.4.17.1	4	4	4	4	4	4	1	1	1	1	—	1	29+
M. tropicalis:													
1889.11.5.1	4	4	4	2	4	1	1	1	1	1	1	1	25
1887.8.5.1	4	4	4	3	4	4	1	3	1	3	1	1	33

The order of suture closure is as follows:

1. Exoccipital—basioccipital.
2. Occipito—parietal.
3. Squamoso—parietal
   Sagittal.
   Coronal.
   Basioccipito—basisphenoid.
7. Basisphenoid—presphenoid.

In Table II the skulls are placed in order of condylo-basal length, and it can be seen that the one known female skull of *M. monachus* has a higher "suture age" in

proportion to its condylo-basal length than the other skulls, i.e. it matures at a smaller size. For this reason it seems likely that the skull and skeleton of *M. tropicalis* 1887.8.5.1 are also from a female.

Table II also shows that the series of skulls of *M. monachus*, although more or less uniformly distributed over a size range, is divisible by " suture age " into two discontinuous groups—those with " suture ages " 12–18 and those from 26–30.

This is clearly shown in the table of percentage increases below, from which it is also evident that while the " suture age " increases from 12–18, an increase of six units, there is a general increase in the size of all the components of the skull, the average amount being 53% or 9% per unit of " age ". During the period when the " suture age " increases by four units from 26 to 30 there is also an increase in all the components with one exception, but the average rate of increase per unit of " age " is now only 4.5%. A diminution in the rate of increase with age is to be expected, but one component—the cranium—appears virtually to have ceased growing by the time a " suture age " of 18 is reached; there are no crania in the 26–30 group larger than the largest individuals in the 12–18 group.

		Percentage increases.					
" Suture age."	Condylo-basal length, mm.	Cranium length.	Inter-orbital length.	Snout length.	Width at canines.	Zygo-matic width.	Width at external audi-tory meatus.
12–18	171–262	46	77	59	39	52	44
19–25	—	Negative	13	8	Negative	7	0·7
26–30	268–295	2	11	24	25	17	15

The most striking feature of the above table is that, despite the absence of any large size discontinuity in the series, there is a complete absence of any specimen in the large " suture " group 19–25; the largest specimens of the " younger " 12–18 group are almost as large as, and in some components larger than the smallest individuals of the " older " 26–30 group.

It is not likely that growth proceeds in this erratic fashion and therefore it is concluded that the " suture age " is not a rectilinear age index. It seems clear that at a certain stage of growth there is a very rapid suture closure. After this stage is past the skull components continue growing with the notable exception of the cranium. Skulls with a condylo-basal length of less than ± 265 mm. have a rapidly growing cranium and during this growth-phase the occipito-parietal, sagittal, coronal and basioccipito-basisphenoid sutures are closing. At ± 265 mm. condylo-basal length there is rapid suture closure affecting the occipito-parietal, squamoso-parietal, sagittal, coronal, basioccipito-basisphenoid and basisphenoid-presphenoid sutures, and cranial growth ceases. After this, growth of the facial elements continues and the interfrontal, intermaxillary, fronto-maxilla, jugal-maxilla, squamosal-jugal and palato-maxilla sutures are open in all the skulls of *M. monachus* in the collection.

It is possible that the " suture age " figures give an approximation to a rectilinear age index if the 19–25 period is eliminated, and if this is done the relative " ages "

of the skulls are 12 : 12 : 13 : 16 : 18 : 23 : 19 : 21 : 23. The "suture age" 12 includes two skulls which are both young but which are clearly at very different stages of growth. The youngest skull—1892.11.7.1—has not been included in the graph as it is so much younger than its "suture age" indicates, this criterion being invalid for very young (and probably very old) skulls.

Plotting the skull measurements against this time scale (Text-fig. 12) gives a

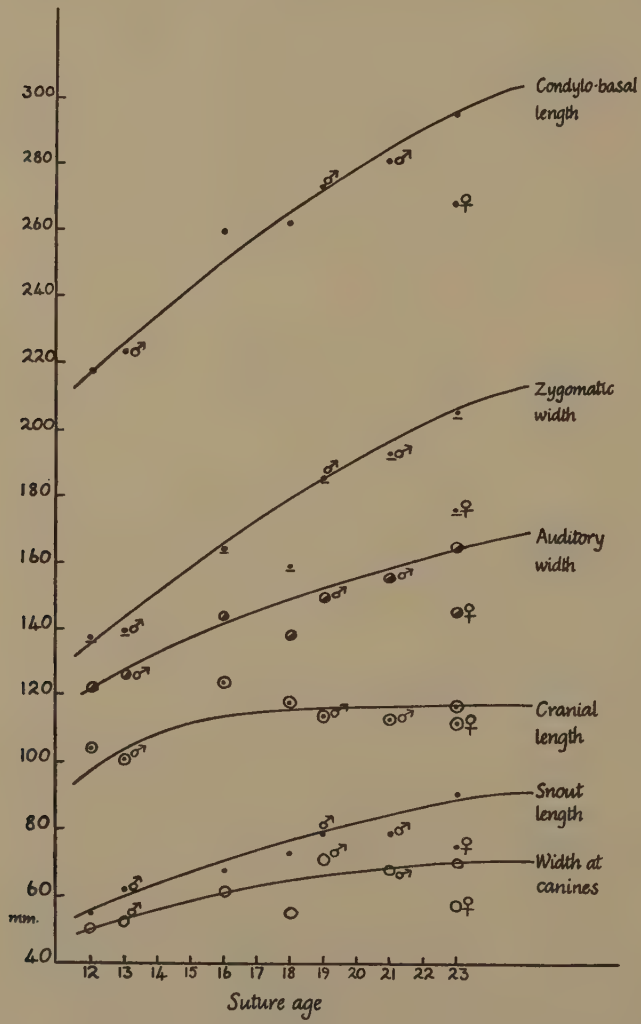

FIG. 12.—Graph showing relative growth rates of different regions of the skull.

picture which is not an unreasonable one, and one which suggests certain sex differences. Even if the time scale is only an approximation, plotting all the bones to this scale gives a series of curves that are directly comparable. The slope and shape of these curves show the relative growth rates and growth patterns of the different elements.

From a visual inspection of a series of skulls of *M. monachus* of ascending size, it is obvious that the various regions of the skull do not all grow at the same rate. The cranium for instance, while it increases in length, does not do so nearly so quickly as the facial region. Measurements of the cranial, interorbital and snout regions were taken between uprights and these, together with width measurements are seen in Table III. The interorbital region is measured to the maxillary tubercle at the anterior edge of the orbit.

The logarithmic values of the various measurements were plotted in turn against the logarithmic value of the condylo-basal length. The points fall approximately about a straight line, showing that there is allometric growth. This being so, it may be taken that the rates of growth of the various parts of the skull relative to the condylo-basal length satisfy the equation $y=bx^k$, where x is the condylo-basal length, y the length of the part, b the fractional coefficient (the value of y when $x=1$) and k the growth coefficient.

TABLE III

Registered No.	Condylo-basal length. mm.	Cranium length. mm.	Inter-orbital length. mm.	Snout length. mm.	Snout width at canines. mm.	Zygo-matic width. mm.	Width at upper edge external auditory meatus. mm.
M. monachus							
1892.11.7.1	171	85	40	46	44	108	100
1063c	217	104	58	55	50	137	122
1894.7.27.3	224	101	61	62	52	139	126
1892.10.4.1	260	124	68	68	61	164	144
1934.8.5.4	262	118	71	73	55	159	139
1894.7.27.2	268	112	81	75	57	176	145
1863.4.1.1	273	114	80	79	71	185	150
1894.7.27.1	281	113	89	79	68	193	156
1951.4.17.1	295	117	87	91	71	205	166

The growth coefficient is the tangent of the angle between the horizontal and the line joining the points. Values of k greater than unity indicate an increasing rate of relative growth, and those less than unity the converse. The following are the values of k for the various parts :

Cranium length	0·62
Interorbital length	1·81
Snout length	1·32
Snout width	0·95
Zygomatic width	1·15
Auditory meatus width	0·85

These figures bear out the visual evidence as they show that the interorbital and snout regions, and the zygomatic width have a much faster relative growth than the rest of the skull, while the cranium, the snout width and the width of the cranium between the external auditory meatuses grow at a much slower rate.

Although fusion of the bones of the skull commences at an early age, the epiphyses of the skeleton do not fuse until comparatively late. The following is the order of fusion of the epiphyses and skeletal elements :

1. Pelvic elements.
2. Sacral vertebrae.
   Humerus (distal).
   Femur (proximal).
5. Vertebral epiphyses.
   Humerus (proximal).
   Radius (proximal).
   Femur (distal).
   Tibia (proximal).
   Fibula (proximal).
11. Ulna (proximal).
    Metacarpal epiphyses.
    Metatarsal epiphyses.
14. Fibula to tibia.
15. Radius (distal).
    Ulna (distal).
    Tibia (distal).
    Fibula (both epiphyses).

Not fused in any specimen in collection.

The above list shows that the epiphyses of the limb bones tend to fuse first to the bones nearest the body—humerus and femur—and the fusion proceeds outwards to the digits. In the youngest animal (1892.11.7.1) the separate elements of the vertebrae have not yet fused, and the fusion of the vertebral epiphyses to the centra in the older animals appears to start at the cervical end of the column and proceed caudally.

In order to see how the limb bones and pelvis increase in length with age, measurements were taken of the lengths of the pelvis and of the shafts of five limb bones, not including the epiphyses, of three male animals of increasing age, and the new-born specimen, as there can be no difference due to sex at this age. There are, unavoidably, many inaccuracies in the table (Table IV). The shaft length is difficult to measure exactly in the two youngest animals because of the large amount of cartilage present where the epiphyses are not fully ossified. The proportions, using the measurements of the largest specimens as 100%, are taken on the assumption that all the animals will grow to this size. This is obviously not so, and even this animal is not fully mature, but it is the oldest that is known to be male. The table shows that the pelvis has over half (62.2%) of its growth in length to complete after the animal is born. The corresponding figures for the limb bones are : humerus 45.4%, radius 50%, femur 54.3%, and tibia 55.4%.

TABLE IV

Registered No.	Humerus. mm.	%	Radius. mm.	%	Femur. mm.	%	Tibia. mm.	%	Pelvis. mm.	%
M. monachus :										
1892.11.7.1	59	54·6	63	50·0	43	45·7	91	44·6	92	37·8
1894.7.27.3 ♂	76	70·0	80	65·1	58	61·7	127	62·2	147	60·4
1863.4.1.1 ♂	101	93·5	118	93·6	88	93·6	186	91·1	221	90·9
1894.7.27.1 ♂	108	100	126	100	94	100	204	100	243	100

RELATIONSHIPS OF THE GENUS *MONACHUS* FLEMING 1822

Family PHOCIDAE Gray, 1825.

Subfamily MONACHINAE Trouessart, 1904.

The Phocidae are divided into the subfamilies Phocinae, including *Phoca*, *Erignathus* and *Halichoerus*, with the incisive formula $\frac{3}{2}$; the Cystophorinae including *Cystophora* and *Mirounga*, with incisors $\frac{2}{1}$; the Lobodontinae, including *Lobodon*, *Hydrurga*, *Leptonychotes*, and *Ommatophoca* with incisors $\frac{2}{2}$; and the Monachinae with the single genus *Monachus* also with incisors $\frac{2}{2}$.

The Cystophorinae are quite distinct, and are not considered here. Some of the characters which distinguish the Phocinae from the Lobodontinae are: the zygomatic process of the maxilla with the posterior border subvertical, not extending far backwards beneath the malar; nails of all the digits well developed; and the outer digits of the pes not much prolonged beyond the others. In the Lobodontinae the zygomatic process of the maxilla is prolonged backwards beneath the malar; the nails of the hind limbs rudimentary; and the outer digits lengthened.

A comparison of members of the genus *Monachus* with members of the two preceding subfamilies shows that in the skull the incisive formula is the same as in the Lobodontinae, the extension backwards of the zygomatic process of the maxilla is not quite so great as in the latter subfamily, but is very much greater than in the Phocinae. All members of the Phocinae have large claws on both fore and hind flippers, while *Monachus* agrees with the Lobodontinae in having the hind claws very much reduced. A further similarity is in the shape of the hind flippers which have the two outer digits very much longer than the inner ones, the first digit of the fore flippers is the longest and the rest get gradually shorter. In the Phocinae the fore flipper is much more square in shape and the digits are more nearly equal. The Phocinae also differ in the position of their nostrils, which are on the anterior end of the snout and more or less vertical. The nostrils of both the Monachinae and the Lobodontinae are nearly on the dorsal surface of the snout and are almost horizontal. As already noted in the various sections on the bones of the skeleton of *Monachus*, these are in general much more like those of the Southern than the

Northern Phocids. The above evidence shows clearly that the Monachinae are more closely related to the Lobodontinae than to the Phocinae.

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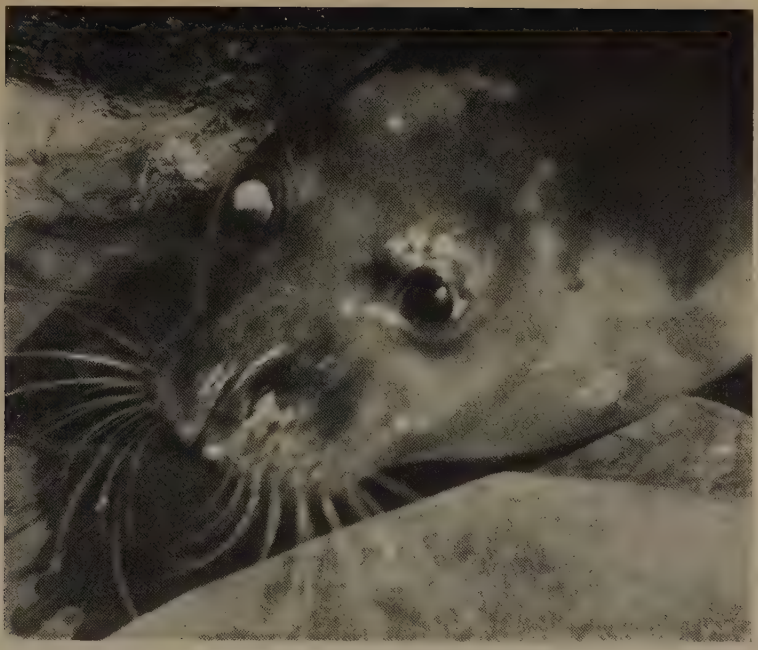
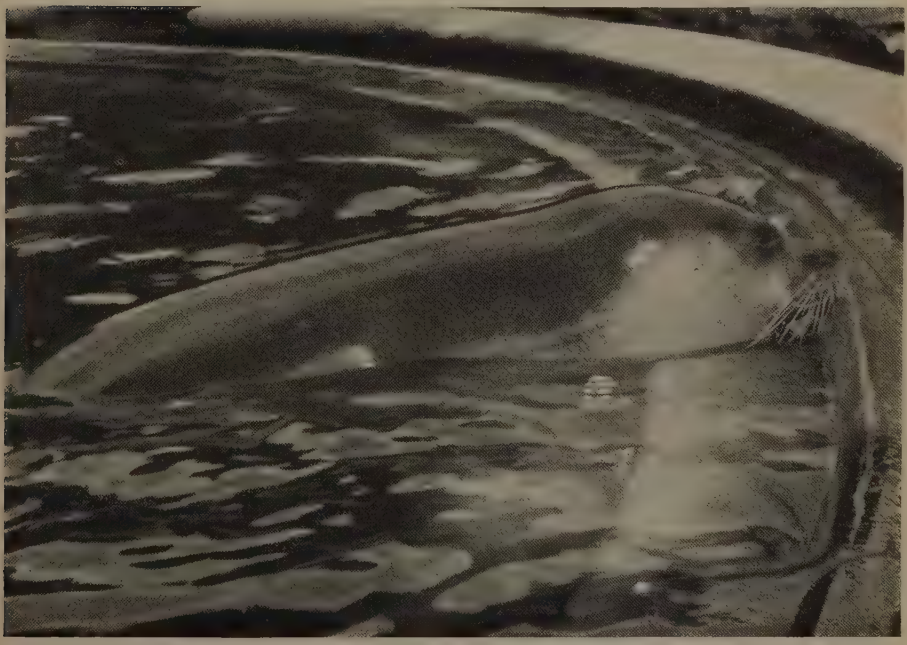
PLATE 3

Monachus monachus. Photographs of the specimen from Oran in the Jardin des Plantes, Paris. The animal was blind in its right eye. Phot. J. E. K.



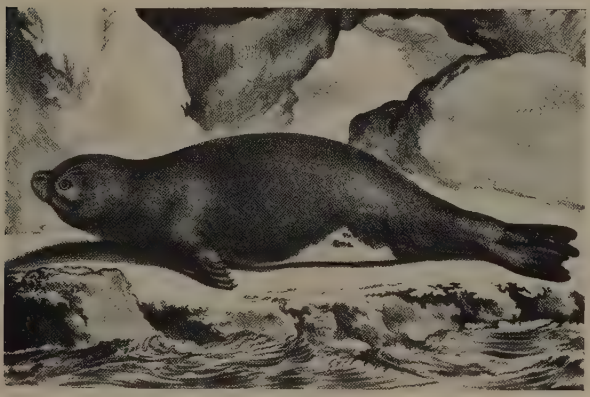


MONACHUS MONACHUS

PLATE 4

Monachus monachus. A. From Hermann, 1779. B. From Buffon, 1782. C. From Pennant, 1793.

A



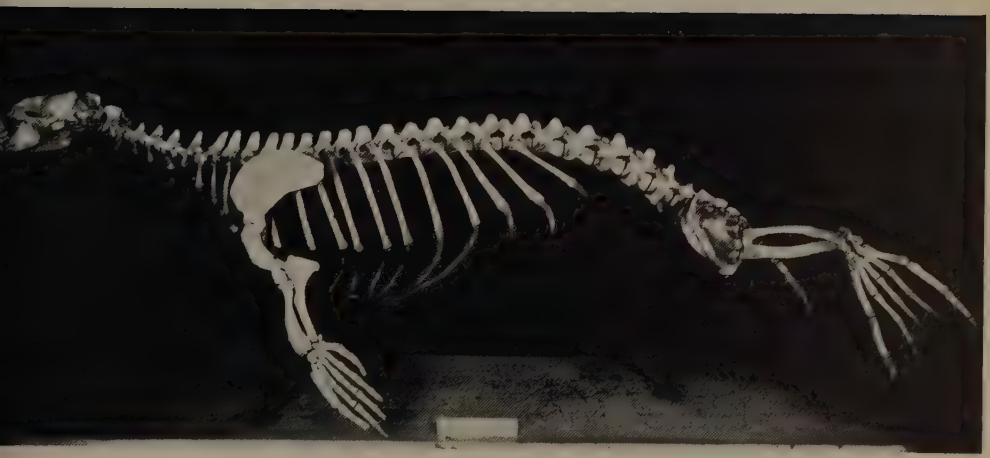
B

C

MONACHUS MONACHUS

PLATE 5

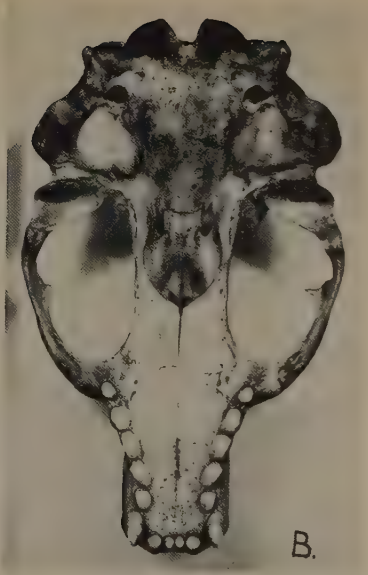
Monachus tropicalis. Lateral view of skeleton 1887.8.5.1.

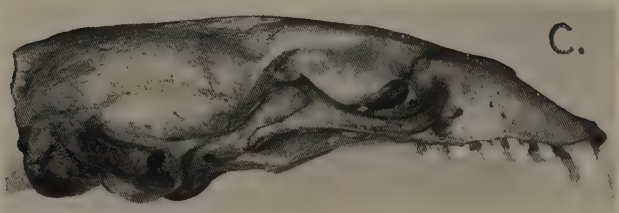


MONACHUS TROPICALIS

PLATE 6

M. schauinslandi. Skull of type specimen No. 32795, Zoological Museum, Berlin. A. Dorsal view. B. Ventral view. C. Lateral view. D. Dorsal view of lower jaw. E. Lateral view of lower jaw.





M. SCHAUINSLANDI

PLATE 7

M. tropicalis. A. Fore limb. B. Hind limb.

A

B

M. TROPICALIS

PLATE 8

Innominate bones of A. *L. weddelli*, B. *M. monachus*, C. *H. grypus*.

A B C

L. WEDDELLI. *M. MONACHUS.* *H. GRYPUS.*

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